Clean Air and Urban Landscapes Hub

National **Environmental Science** Programme

Risks to Australia's urban forest
from climate change and urban heat

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This report was prepared to contribute to improved understanding and management of Australia's urban forests. It also contributes to satisfying the outputs for CAUL subproject 3.4 "Assessing the vulnerability of Australian cities' green infrastructure to climate change".

About the Clean Air and Urban Landscapes Hub

The Clean Air and Urban Landscapes Hub (CAUL) is a consortium of four universities: the University of Melbourne, RMIT University, the University of Western Australia and the University of Wollongong. The CAUL Hub is funded under the National Environmental Science Programme of the Australian Government's Department of the Environment. Our task is to undertake research to support environmental quality in our urban areas, especially in the areas of air quality, urban greening, liveability and biodiversity, and with a focus on applying research to develop practical solutions

Executive Overview

Australian cities contain millions of trees that provide amenity, important ecosystem services such as cooling and slowing stormwater, and provide habitat for birds and animals. There is growing recognition that increasing temperatures due to urban heat and climate change are a threat to some tree species in our cities. This study analyses the risk of temperature increases to 1.9 million trees in 29 LGAs across Australia, from Launceston to Darwin, and Brisbane to Perth. Every tree was analysed to see how close it was to known temperature limits in current climates, an emissions limited climate change scenario in 2040 assuming emissions stabilisation, and a business as usual emissions scenario in 2070.

We find that 14% of all public trees (22% of species) in Australia's cities are at high risk (red flagged) from increased temperatures in the emissions limited climate change scenario, and 24% of all public trees (35% of species) in the business as usual emissions scenario by 2070. A further 33% of trees are at some risk (yellow or orange flagged) in the emissions limited scenario and 29% in the business as usual scenario. There is great variation in the risk to urban trees of temperature increases from city to city, and across areas within each city.

This risk from increasing temperatures will present a major challenge to land managers across Australia. There are likely to be unequal impacts on the different benefits provided by the forest (e.g. cultural heritage, biodiversity), and these impacts vary from place to place. Change in management of natural areas and natural resources can lead to conflict. Urban trees are important to people for different reasons, and a wide range of concerns must be addressed when planning our urban forests of the future. Particular care must be taken so the inequality in the distribution of urban trees is not reinforced when planning and managing this change, and that 'maladptation' leading to feedback loops with increasing temperatures (e.g. through reduced shade) does not occur.

There are several strategies that are available for urban forest managers to adapt to increasing temperatures. For important trees, a strategy of resistance can be used to improve the environmental conditions and prolong useful life e.g. by providing irrigation or improved pest and disease management. More generally, a strategy of promoting resilience can be used e.g. through careful site selection for vulnerable species, and improved tree maintenance. Lastly, managers can respond to change by selecting trees that are better adapted to future climates.

While this report has focussed on the risks of increasing temperatures, there are also many opportunities that will arise from this. New tree species will need to be introduced to our cities to maintain resilience and provide a wide range of benefits. We have an opportunity to improve the sustainability of our cities through this renewal process. Meaningful engagement with the community and industry will help create successful urban forests of the future that provide a wide range of benefits for people and wildlife in cities.

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Foreword

In 2012, The City of Melbourne released an Urban Forest Strategy, a globally recognised blueprint for cooling the city and directly responding to climate change. One of the main outcomes of the strategy is an increase in tree planting to respond to anticipated tree loss and to achieve greater canopy cover.

Through urban forest planning, the City of Melbourne identified that whilst future tree planting will adapt the city to climate change, limited information was available regarding the expected impact of climate change on the urban forest.

To address this critical information gap, the City of Melbourne commissioned the Future Urban Forest report (CAUL, 2016). The Future Urban Forest report was specifically to examine the vulnerability of the City's current urban forest and to identify climate resilient species for planting into the future.

The Future Urban Forest report is now one of the City of Melbourne's primary tools for tree selection and for future urban forest planning. The research outcomes are both compelling and liberating, identifying hundreds of potential new species for planting in Melbourne into the future.

We are very pleased that through CAUL, this works has been now applied to a national context and expect that the outcomes will prove to be most useful for urban forest managers across Australia now and into the future.

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Introduction

Australia's urban Forests

Despite its vast area, Australia is a very urbanised continent. Most people in Australia live in cities, and the urban environment is where most people experience nature. Historically, most Australian cities had large suburban areas with detached housing and residential gardens, many with trees. Similarly, most Local Government Authorities (LGAs) have had well established public tree programs, and many Australian streets and parks are lined with trees: 41% of houses in Australia's capital cities have a street tree (Kirkpatrick et al., 2011). More recently, there has been a push for increased urban densification, resulting in the loss of some private green space in established areas and reduced private green space in new developments. This has made the public tree estate more important as trees are being lost, or added at a reduced rate, to the private tree estate.

Like Australia's cities, our urban trees come from a wide range of climates, from tropical and subtropical areas in the north (Plant and Sipe 2016) to cool temperate areas in the south (Frank et al., 2006; Kendal et al., 2012a). We have always known that climate is an important consideration for urban trees. While this has mostly been focussed on minimum temperatures and drought, there is increasing awareness that temperature is an important influence on the distribution of trees in all climates (Kendal et al., 2012b). Consequently, increasing temperatures due to urban heat and climate change are likely to affect the composition and abundance of Australia's urban trees. This report combines several global datasets to explore the risk that Australia's urban trees face from increasing temperatures.

Urban heat

The conversion of natural landscapes into urban landscapes can dramatically alter the local climate. The urban heat island (UHI) is a phenomenon where urban areas become warmer than the surrounding rural countryside, often by several degrees (Figure 1; Coutts, Beringer et al. 2010). This temperature difference is usually greater at night than during the day and is driven by heat that is trapped and stored in the urban landscape during the day and then slowly released at night, while rural areas cool uninhibited (Kim 1992). While the UHI effect is greater in larger cities, a smaller but still significant UHI effect can be detected even in small towns (Oke 1973; Torok, Morris et al. 2001).

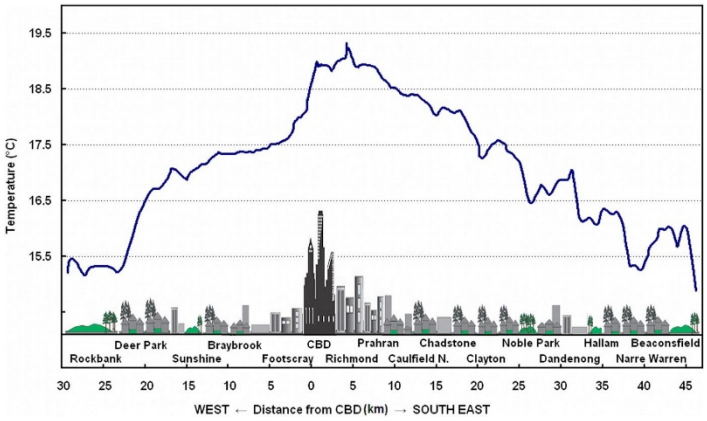
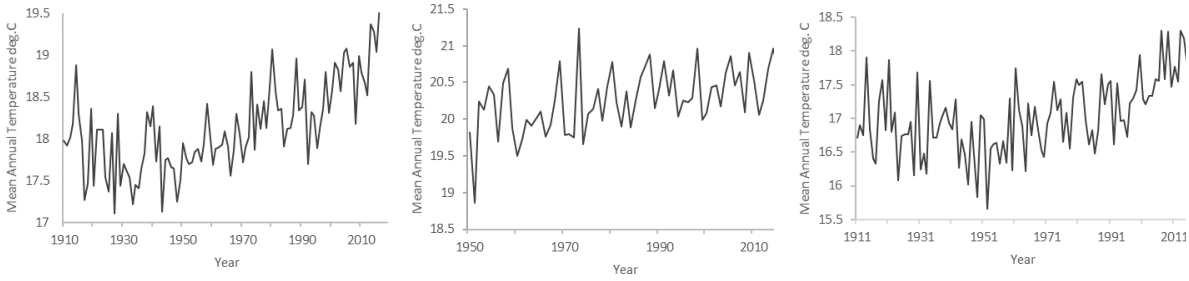


Figure 1: Spatial variability of Melbourne's urban heat island effect with the maximum urban heat island intensity (approximately 4C) recorded in areas of the highest commercial and residential development in Melbourne's CBD. Figure modelled by and reproduced from Coutts et al., 2010.

Australian cities currently experience the effects of urban heat (Torok, Morris et al. 2001; Coutts, Beringer et al. 2010). For example, the City of Melbourne's mean annual temperature 20-year average has increased from 14.7 °C in 1950 to 16.4 °C in 2005. This increase is more pronounced in minimum (i.e. overnight) temperatures, although increases in daytime temperatures have also been observed. Similar increases in mean annual temperate have been recorded in cities across Australia including Sydney, Brisbane and Adelaide (Figure 2). While some of these changes are very likely due to human induced global warming (via CO_2 emissions), the magnitude of these changes have been exacerbated by other factors such as the urban heat island effect.

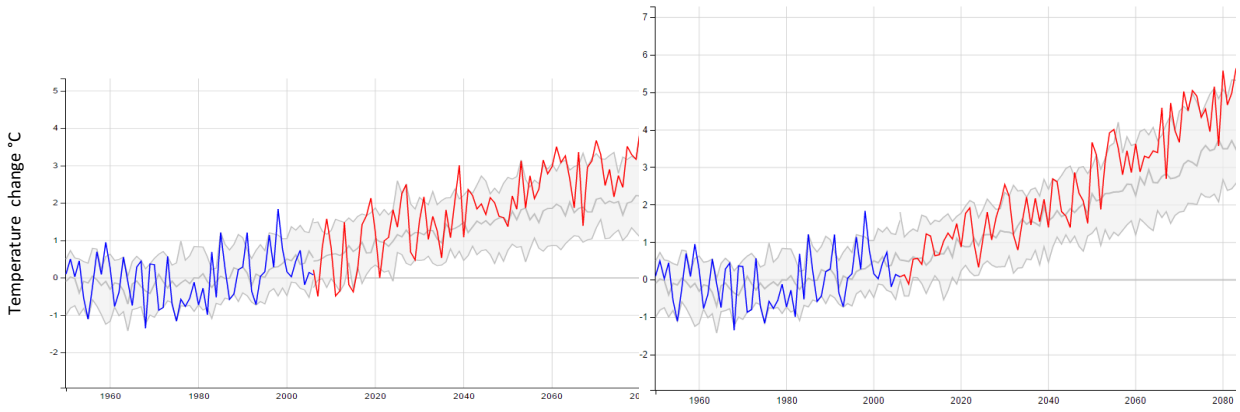


a) Sydney *b) Brisbane* *c) Adelaide*

Figure 2. Change in mean annual temperature over time in a) Sydney, b) Brisbane, and c) Adelaide

Climate change projections

Different emission scenarios are modelled based on assumptions about whether the world will be able to limit global emissions (RCP4.5 scenario) or allow emissions to continue to increase in a business-as-usual scenario (RCP8.5 scenario). These models determine the probability of the direction and size of change in particular climate variables such as temperature. They models predict *additional* temperature increases in the Townsville region of approximately 1.3°C in an emissions limited climate scenario (RCP4.5 by 2040) and 3°C under a business as usual scenario (RCP 8.5 by 2070) (Figure 3), and similar increases in other regions.



a) RCP4.5 for the Monsoonal North (East) region *b) RCP8.5 for the Monsoonal North (East) region*

Figure 3 Change in mean annual temperature for different Australian regions under different emissions scenario predicted using the ACCESS1-3 model by CSIRO/BOM. Generated using the Time Series Explorer tool provided by climatechangeinaustralia.gov.au

Trees and increasing temperatures

The distribution of a plant species is limited by the range of climatic conditions to which the species can adapt (Criddle, Hopkin et al. 1994), and one of the strongest determinants of geographical distribution of plants is temperature (Woodward and Williams, 1987). Plants have temperature tolerance limits that reflect adaptation to their native habitats, with temperature extremes defining the geographic limits for plant survival and reproduction (Hatfield and Prueger 2015). It is often assumed that trees can be cultivated in places that are much hotter or colder than their natural ranges, although in practice there is often a close relationship between the temperature in natural distributions and temperature in cultivation (Figure 4). Predicted increases in temperature from urban heat and climate change can shift the environment to the edge of, or even outside, some species' temperature envelopes (Figure 4).

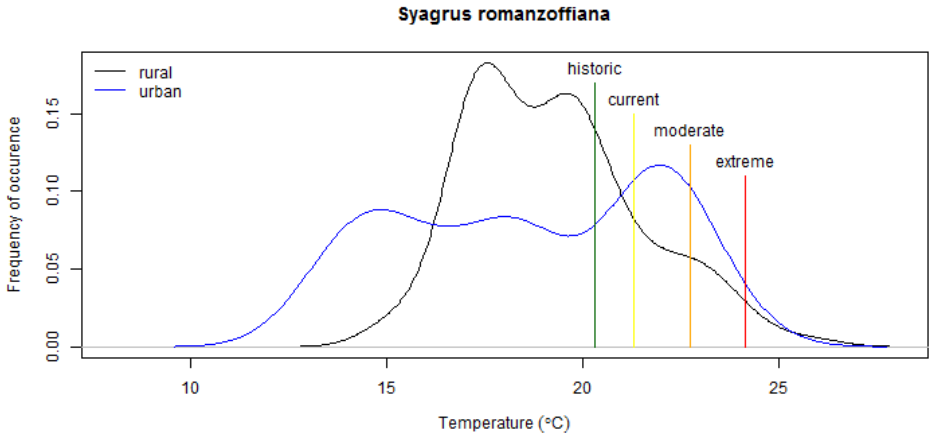


Figure 4: Mean annual temperature envelope of Syagrus romanzoffiana (Queen Palm). Brisbane's historic mean annual temperature (green), current mean annual temperature including urban heat (yellow), predicted mean annual temperature in an emissions limited climate change future (orange) and business as usual climate change future (red) are shown as vertical lines.

Methodology

The climate vulnerability of trees from 29 Local Government Areas (LGA) across Australia was assessed by comparing the mean annual temperature of locations where species naturally occur and are known to be cultivated, with several temperature projections for the climate future of these LGA's. Spatially explicit climate data (BIOCLIM) was obtained from Worldclim, for historic temperatures (mostly excluding urban heat), an emission limited climate change scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070). Urban heat was estimated for every city, based on weather data published by the Bureau of Meteorology.

*Table 1 – Current and future temperature projections of mean annual temperature (MAT) in degrees °C averaged across all trees in the LGA. * values are lower than expected as some urban heat is included in the BIOCLIM data used*

LGA	Metropolitan area	Urban heat	Current MAT	RCP4.5 MAT	RCP8.5 MAT
Burnside	Adelaide	1.5	17.2	17.2	18.4
City of Adelaide	Adelaide	1.5	17.9	17.9	19.1
Prospect Shire	Adelaide	1.5	17.9	18.0	19.2
Ballarat	Ballarat	0.5	12.6	13.7	15.0
Brisbane	Brisbane	1.5	21.8	21.7	23.1
Corangamite Shire	Camperdown and others	0.5	13.8	14.7	15.7
Canberra	Canberra	1	13.8	14.4	16.2
Colac-Otway Shire	Colac and others	0.5	13.8	14.7	15.8
Darwin	Darwin	0.5	27.9	29.0	30.6
Geelong	Geelong	0.5	14.8	15.9	17.0
Southern Grampians Shire	Hamilton and others	0.5	13.7	14.7	15.8
Launceston	Launceston	0*	12.3	13.9	15.2
Brimbank	Melbourne	1	15.5	16.1	17.4
Casey	Melbourne	0.5	14.9	16.1	17.3
City of Melbourne	Melbourne	1.5	16.3	16.5	17.8
Hobsons Bay	Melbourne	1	15.7	16.3	17.6
Hume	Melbourne	0.5	14.5	15.7	17.0
Manningham	Melbourne	1	15.5	16.2	17.5
Maroondah	Melbourne	1	15.2	15.9	17.2
Moonee Valley	Melbourne	1.5	16.2	16.3	17.6
Moreland	Melbourne	1.5	16.1	16.3	17.6
Whittlesea	Melbourne	0.5	14.7	15.9	17.3
Ciy of Perth	Perth	1*	19.7	20.2	21.3
Fremantle	Perth	1*	19.5	20.0	21.1
Glenelg Shire	Portland and others	0.5	14.2	14.9	15.9
Shepparton	Shepparton	0.5	15.7	17.1	18.6
City of Sydney	Sydney	1.5	19.1	19.2	20.8
Marrickville	Sydney	1.5	19.1	19.2	20.8
Townsville	Townsville	0*	24.1	25.6	26.8

Spatially explicit tree inventories were supplied by all LGAs participating in this study, either directly or via open data platforms (e.g. data.gov.au). This dataset contained 1392 distinct species and 1.9 million distinct point records. The global distribution of trees was determined using data from The Global Biodiversity Information Facility (www.gbif.org) which has 650 million occurrence records from over 1.5 million species globally. Occurrence records include natural distributions, weed records and some urban records. A total of 3.4 million observations of the species of interest were used in the analysis. The location of the GBIF records was used to determine the temperature of occurrence of these (mostly) rural trees.

A second dataset, urban tree inventories, was manually collected from over 400 urban tree inventories worldwide that were published in academic papers and government reports. Over 25,000 records were included in this dataset. Note for the purposes of this research, cultivars were included as species only as little data exists on their provenance and climatic suitability (e.g. they are

not represented in the GBIF database). The location of the city where the inventory was collected was used to determine the temperature of occurrence of these urban trees.

A global mean annual temperature 'window' was calculated for the 1290 tree species that could be matched to global tree datasets. Every tree occurrence in every city was located within the species-level temperature window, separately for the current climate (including urban heat), and for emissions limited (RCP4.5) and business as usual (RCP8.5) climate future scenarios. Where the location was close to the upper limit of the window, the occurrence was considered at risk in that climate. A colour-coded risk scheme was developed based on this location within the temperature window (Figure 5, Table 2). For example, where the temperature is above the 97.5th percentile of a species known temperature window, that species is considered most at risk due to heat and colour coded as red. Risk then decreases away from these limits (orange=90-97.5th, Yellow=80-90th).

Table 2 – Temperature risk colour coding scheme.

Rating	Metric	Description
Green	The temperature is similar to most locations where this species is found (i.e. the temperature is below the 80th percentile)	The species is not considered at risk from increasing temperatures
Yellow	The temperature warmer than most locations where the species occurs (i.e. temperature > 80th percentile)	The species is slightly at risk from increasing temperatures
Orange	The temperature is warmer than 90% of the locations where this species is found (i.e. the temperature > 90th percentile)	The species is moderately at risk from increasing temperatures
Red	The temperature is warmer than 97.5% of the locations where this species is found (i.e. the temperature > 97.5th percentile)	The species is at high risk from increasing temperatures

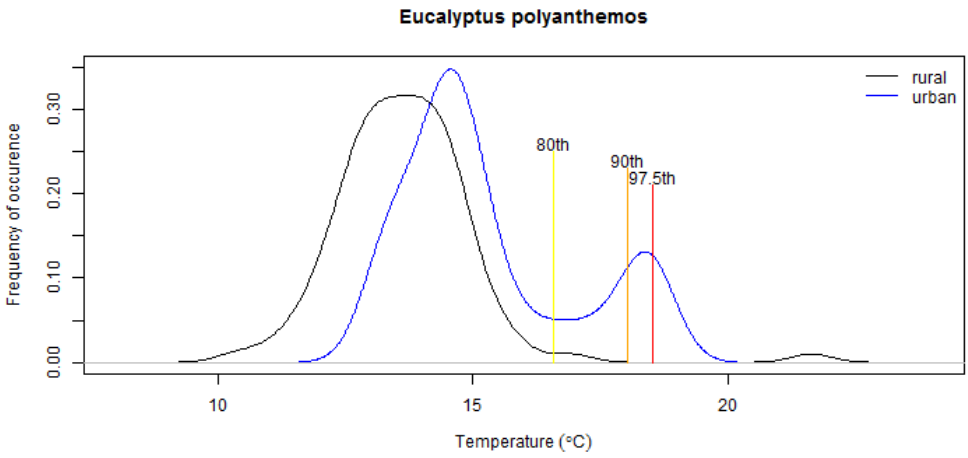


Figure 5: The key temperature parameters used in determing vulnerability for Corymbia citriodora. *Coloured vertical lines indicate the temperature thresholds used in this study.*

Findings

Of the 1,392 trees species recorded across the 29 LGA's, 1,290 (92.7%) of these species had good coverage in our databases, and close to 1.5 million individual tress were able to be assessed for climate risk (Table 3). Overall, we find that 14% of all public trees (22% of species) in Australia's cities are at high risk (red flagged) from increased temperatures in the emissions limited climate change scenario, and 24% of all public trees (35% of species) in the business as usual emissions scenario by 2070. A further 33% of trees (32% of species) are at some risk (yellow or orange flagged) in the emissions limited scenario and 29% of trees (34% of species) in the business as usual scenario (Tables 4 & 5).

The proportion of species considered at risk to increasing temperatures from climate change and urban heat varies across LGA's (Figure 5). For example, of the current species in Fremantle, 46% will occur outside of known temperature ranges in Townsville's emissions limited future climate (red flagged) and a total of 55% in Fremantle's business as usual climate scenario. This is even higher in Darwin, although these figures should be treated with some caution and likely reflect limitations in the availability of data for trees in very hot climates. When looking at individual trees, 50% of trees in Fremantle are highly at risk in the emissions limited future climate (red flagged) and this increases to 61% of trees in the business as usual climate scenario. In comparison, of the current species in Ballarat, only 1% of tree species largely occur outside of Ballarat's emissions limited future climate (red flagged) and a total of 10% of species occur outside of Ballarat's business as usual climate scenario. When looking at individual trees, 0% of trees in Ballarat are highly at risk in the emissions limited future climate (red flagged) and 1% of trees are considered at high risk in Ballarat's business as usual climate scenario.

It is important to note that these figures reflect risk rather the certainty of declining health or direct tree mortality. Climate-related tree deaths are commonly caused by drought stress or extreme heat events, not gradual changes in mean annual temperature. There are undoubtedly species that will continue to thrive in cities as temperatures increase, despite their being no records of them growing in these temperatures. However, in the long term and on average across many species, it is likely that trees will perform better when they are in the middle of their climatic ranges. The work presented in this report can contribute to informed decision making, but should be considered in the context of other information that may be available (e.g. tree health information).

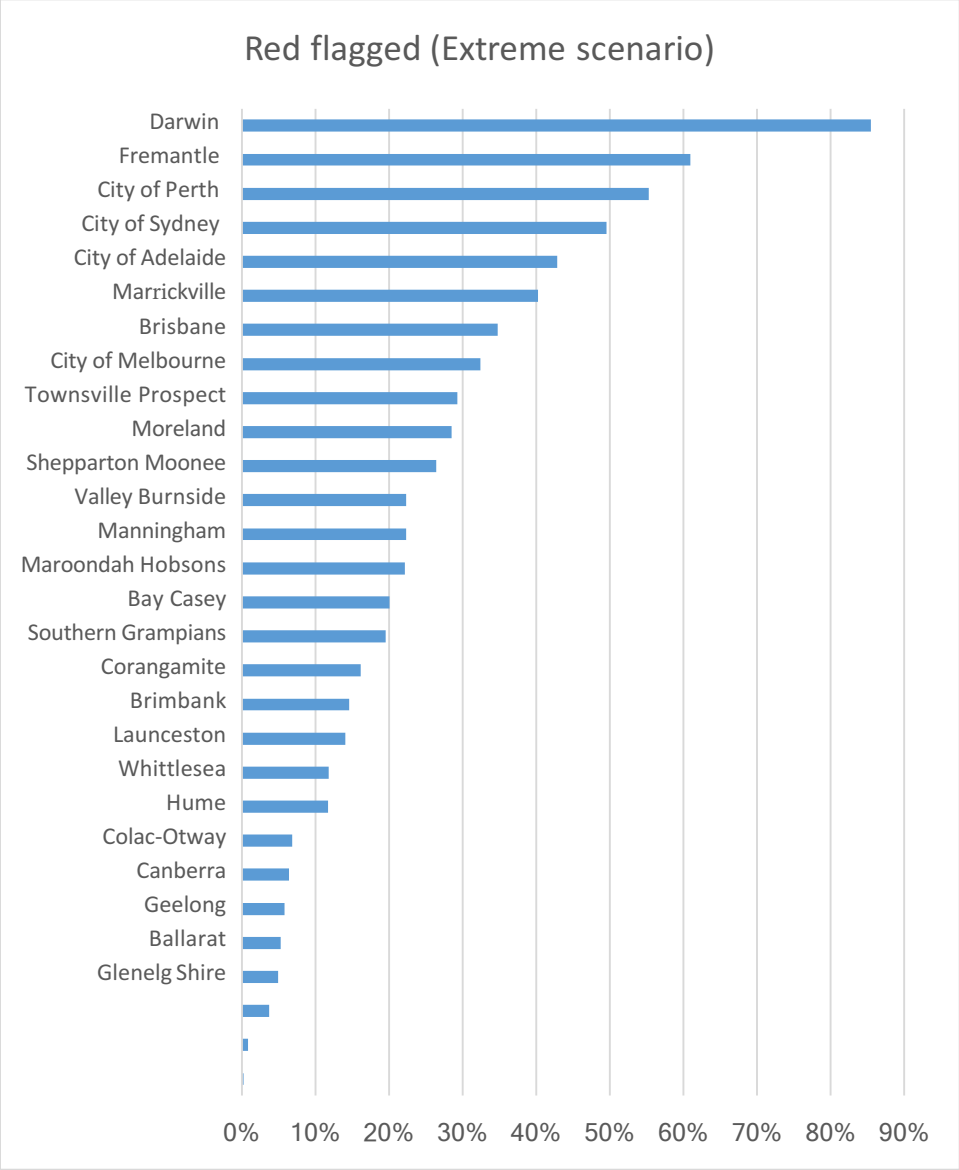


Figure 6: The proportion of trees red-flagged in each LGA under the business as usual (RCP8.5) climate change scenario.

Table 3 - Number of species and trees assessed per LGA.

LGA	Metropolitan area	Species	Species assessed	Trees	Trees assessed
City of Burnside	Adelaide	315	306	34212	33432
City of Adelaide	Adelaide	65	64	6029	5978
City of Prospect	Adelaide	50	36	11170	8217
City of Ballarat	Ballarat	242	237	67807	27248
City of Brisbane	Brisbane	182	148	9098	8424
Corangamite Shire	Camperdown and others	361	353	15493	14773
Canberra	Canberra	323	316	446734	356547
Colac-Otway Shire	Colac and others	130	128	3421	3408
City of Darwin	Darwin	46	41	1109	947
City of Greater Geelong	Geelong	232	220	146678	63143
Southern Grampians Shire	Hamilton and others	135	117	5048	4150
City of Launceston	Launceston	359	349	30369	27725
Brimbank City Council	Melbourne	657	635	180139	143024
City of Casey	Melbourne	339	329	119310	114679
City of Melbourne	Melbourne	420	414	67462	66022
Hobsons Bay City Council	Melbourne	408	396	67963	67643
Hume City Council	Melbourne	493	481	209785	130580
Manningham City Council	Melbourne	449	426	69570	58347
Maroondah City Council	Melbourne	375	367	64288	63686
Moonee Valley City Council	Melbourne	233	193	44033	41432
Moreland City Council	Melbourne	351	341	73958	54300
City of Whittlesea	Melbourne	319	317	77748	77424
City of Fremantle	Perth	186	180	9971	9934
City of Perth	Perth	233	228	12096	12087
Glenelg Shire	Portland and others	37	35	3758	2874
Greater Shepparton City Council	Shepparton	376	362	38678	38213
City of Sydney	Sydney	311	298	38987	38805
Marrickville	Sydney	413	400	34969	31682
City of Townsville	Townsville	122	110	20076	14613
	Total	*1392*	*1290*	1909959	1520045

Table 4: Proportion of tree species at risk under future climate scenarios for each of LGA

		TREE SPECIES							
		Emissions Limited scenario (RCP4.5)				**Business as usual scenario (RCP8.5)**			
LGA	METROPOLITAN AREA	green	yellow	orange	red	green	yellow	orange	red
City of Burnside	Adelaide	31%	17%	26%	26%	20%	16%	18%	45%
City of Adelaide	Adelaide	23%	23%	25%	28%	19%	11%	39%	31%
City of Prospect	Adelaide	28%	14%	19%	39%	22%	8%	19%	50%
City of Ballarat	Ballarat	78%	14%	8%	1%	58%	18%	14%	10%
City of Brisbane	Brisbane	38%	19%	16%	27%	30%	9%	19%	42%
Corangamite Shire	Camperdown etc	71%	14%	11%	4%	56%	20%	13%	11%
Canberra	Canberra	54%	17%	17%	12%	29%	22%	21%	28%
Colac-Otway Shire	Colac etc	70%	17%	8%	5%	61%	14%	15%	10%
City of Darwin	Darwin	0%	0%	2%	98%	0%	0%	0%	100%
City of Greater Geelong	Geelong	58%	20%	14%	9%	42%	16%	25%	17%
Southern Grampians Shire	Hamilton etc	64%	17%	15%	4%	52%	21%	17%	10%
City of Launceston	Launceston	68%	16%	10%	6%	52%	18%	13%	16%
Brimbank City Council	Melbourne	40%	23%	19%	18%	24%	14%	22%	40%
City of Casey	Melbourne	56%	21%	13%	10%	34%	19%	26%	21%
City of Melbourne	Melbourne	38%	15%	21%	25%	23%	14%	21%	43%
Hobsons Bay City Council	Melbourne	43%	20%	21%	16%	22%	18%	20%	39%
Hume City Council	Melbourne	57%	20%	12%	11%	36%	19%	24%	21%
Manningham City Council	Melbourne	43%	23%	20%	14%	23%	17%	24%	36%
Maroondah City Council	Melbourne	44%	22%	19%	14%	24%	16%	26%	34%
Moonee Valley	Melbourne	42%	22%	22%	13%	19%	21%	28%	32%
Moreland City Council	Melbourne	36%	20%	25%	19%	19%	15%	23%	43%
City of Whittlesea	Melbourne	61%	16%	12%	11%	36%	19%	25%	20%
City of Perth	Perth	32%	13%	18%	38%	23%	11%	18%	47%
City of Fremantle	Perth	28%	9%	17%	46%	22%	12%	12%	55%
Glenelg Shire	Portland etc	89%	9%	0%	3%	69%	26%	3%	3%
Greater Shepparton City Council	Shepparton	41%	19%	25%	15%	19%	14%	24%	43%
City of Sydney	Sydney	32%	15%	17%	37%	19%	12%	20%	49%
Marrickville	Sydney	24%	13%	20%	44%	15%	8%	19%	58%
City of Townsville	Townsville	34%	9%	15%	42%	16%	12%	15%	57%
	AVERAGE	**46%**	**16%**	**16%**	**22%**	**30%**	**15%**	**19%**	**35%**

Table 5: Proportion of individual trees at risk under future climate scenarios for each LGA

		INDIVIDUAL TREES							
		Emissions Limited scenario (RCP4.5)				**Business as usual scenario (RCP8.5)**			
LGA	METROPOLITAN AREA	green	yellow	orange	red	green	yellow	orange	red
City of Burnside	Adelaide	43%	27%	14%	16%	32%	16%	6%	22%
City of Adelaide	Adelaide	13%	18%	26%	43%	12%	2%	27%	43%
City of Prospect	Adelaide	24%	34%	6%	26%	24%	2%	4%	28%
City of Ballarat	Ballarat	21%	19%	1%	0%	15%	15%	1%	1%
City of Brisbane	Brisbane	37%	33%	14%	14%	29%	9%	10%	35%
Corangamite Shire	Camperdown etc	65%	24%	11%	1%	50%	20%	10%	12%
Canberra	Canberra	46%	29%	6%	0%	20%	28%	7%	5%
Colac-Otway Shire	Colac etc	81%	13%	5%	2%	72%	18%	1%	5%
City of Darwin	Darwin	0%	0%	1%	84%	0%	0%	0%	85%
City of Greater Geelong	Geelong	78%	9%	5%	1%	62%	15%	4%	4%
Southern Grampians Shire	Hamilton etc	38%	30%	13%	4%	29%	33%	3%	14%
City of Launceston	Launceston	63%	29%	5%	1%	47%	30%	4%	7%
Brimbank City Council	Melbourne	48%	19%	10%	3%	16%	23%	7%	12%
City of Casey	Melbourne	51%	32%	11%	5%	31%	37%	8%	15%
City of Melbourne	Melbourne	38%	18%	24%	18%	25%	10%	13%	32%
Hobsons Bay City Council	Melbourne	68%	20%	10%	2%	23%	28%	14%	16%
Hume City Council	Melbourne	73%	19%	6%	1%	47%	28%	5%	6%
Manningham City Council	Melbourne	47%	30%	18%	4%	21%	23%	14%	20%
Maroondah City Council	Melbourne	59%	23%	16%	4%	32%	26%	9%	19%
Moonee Valley	Melbourne	46%	23%	21%	9%	13%	28%	24%	22%
Moreland City Council	Melbourne	48%	30%	16%	6%	16%	26%	11%	26%
City of Whittlesea	Melbourne	70%	23%	6%	1%	42%	26%	10%	6%
City of Perth	Perth	26%	10%	30%	33%	8%	21%	9%	55%
City of Fremantle	Perth	20%	7%	23%	50%	15%	11%	12%	61%
Glenelg Shire	Portland etc	81%	2%	0%	0%	63%	19%	0%	0%
Greater Shepparton City Council	Shepparton	61%	13%	20%	7%	22%	20%	14%	22%
City of Sydney	Sydney	32%	9%	39%	20%	12%	22%	12%	50%
Marrickville	Sydney	44%	12%	21%	22%	29%	19%	5%	40%
City of Townsville	Townsville	38%	11%	19%	17%	11%	17%	13%	29%
	AVERAGE	**47%**	**19%**	**14%**	**14%**	**28%**	**20%**	**9%**	**24%**

Implications for urban forest management

Urban forest governance in a changing climate

Judy Bush

The governance and management of Australia's urban forest reflects the diversity of benefits provided by the urban forest: mitigating urban heat, managing stormwater quality and quantity, improving air quality, providing biodiversity habitat and contributing to landscape values and aesthetics. Urban forest governance is multi-level and cross-disciplinary, with multiple government and non-government stakeholders involved. It spans a range of government departments and levels, as well as community organisations, local residents, businesses and utilities.

As such, the management of risks to the urban forest associated with climate change and urban heat is complex, with costs and benefits unevenly distributed across stakeholders. Depending on the respective priorities and values of different stakeholders, specific trees may simultaneously be providing ecosystem services and disservices, creating potential arenas for duplication, cross-over and conflict over tree management and the allocation of risks, costs and responsibilities.

As the impacts of climate change and urban heat increasingly affect the health of existing trees, urban forest governance must be equipped to address these challenges, which will include decision-making on the timing of removal of sick, dying or dead trees, appropriate species for replacement in different locations and provision of funding and resources for these programs. These decision-making processes will necessitate engagement across the range of urban forest governance stakeholders, including government and non-government stakeholders.

It should be noted that the analysis presented in this report relates only to trees within the public domain. There is a substantial population of trees on private land that is not included in these findings, and whose management is beyond the scope of this report.

Management implications

The prospect of changes to a city's urban forest has the potential to be met with resistance and protest from some of the urban forest's stakeholders. Therefore, proactive responses that involve ongoing, active and collaborative processes of engagement, discussion, envisioning the future urban forest and decision-making are necessary.

Actively engaging with the range of stakeholders, in continuing (not one-off) processes of discussion, decision-making and input to active management in some jurisdictions has contributed to building broader stewardship of the urban forest. Furthermore, communicating the wide range of urban forest benefits may support the necessary involvement across policy domains and with the broader community. Decision-making on the future species composition of the urban forest should seek to integrate a wide range of benefits and ecosystem services associated with the suite of selected species.

Key success factors associated with transitions in urban forest policy and governance include:

- Building a shared vision of the urban forest and its multiple benefits and contributions
- Fostering urban forest champions and leaders, as well as broad-based partnerships across government departments and with non-government stakeholders
- Integrating urban forest policies with other urban policy domains, particularly land use planning, transport and health, as well as urban ecology and open space management
- Provision of funding and resources, and ensuring availability of technical expertise
- Sharing information across jurisdictional boundaries and between Australian cities
- Monitoring and evaluation to support continuing adaptations to species composition, and to governance, management and engagement processes.

Tree planning and management in a changing environment

Dave Kendal & Alison Farrar

Understanding the consequences of climate change for urban trees is particularly important for land managers and planners. Increasing temperatures and the duration and severity of drought and heat stress events associated with climate change is altering the composition and structure of forests globally (Allen, Macalady et al. 2010). Of particular concern is declining tree health and the potential increases in individual tree mortality associated with climate induced physiological stress and other climate-mediated processes such as pest and disease outbreaks. In extreme cases, species may disappear from particular places.

While the risks to current species in future climates may seem dramatic there are many other species that may be more suitable in future conditions. Land managers have a unique opportunity to shape their city's adaptation and resilience to climate change through sensible plant selection of a diverse range of trees that are likely to perform well and maintain or improve ecosystem services and ecological functioning in response to increasing temperatures. However, as there will be greater uncertainty about the outcomes of management actions for new species, processes will need to be developed to select and test these species in order to determine their suitability for different purposes and in different conditions.

Management implications

Land managers face the challenge of integrating adaptation and mitigation strategies into the planning of the future urban forest. Millar et al. (2007) proposed a framework that outlines three actions that can help land managers accommodate changes.

Action 1: Resisting change

Building resistance of individual trees to the changing future climates can be achieved by anticipating the impacts of future conditions and protecting trees of high value (e.g. those on Significant Tree registers). Managers can take actions to ameliorate local conditions for trees of high value, such as providing irrigation, mulching, controlling pests and diseases, and improving the abiotic environment (e.g. drainage, aeration, fertilisation, mycorrhizal innoculation).

Action 2: Promoting resilience to change

Building resilience to future climates improves the capacity of the urban forest to cope with future conditions and disturbance. Managers can promote resilience to future climates through actions such as identifying suitable microclimates for species at risk, increasing the use of irrigation, improving soil conditions and planting techniques, using better quality stock, and extending establishment maintenance.

Action 3: Responding to change

Responding to the changing climate involves accommodating change rather than resisting it, and encouraging gradual adaptation and transition of the urban forest to inevitable change. The main actions urban forest managers can take to respond to the changing conditions is to change species selection to favour less vulnerable species under future conditions. While there are many new species that will be potentially suitable for future climates, there will be greater uncertainty about the outcomes of managing these species. Key factors leading to success include:

1) Liaison with the nursery industry in purchasing plants for the future is essential. There is a long lead-time in the supply of advanced trees, and changes in future ordering patterns need to be communicate clearly in consultation with the nursery industry.
2) Diversity is a critical component of the resilience of the urban forest (Kendal, Dobbs et al. 2014). Maintaining or enhancing diversity is vital to maintain a healthy urban forest that

continues to provide ecosystem services in the face of global environmental change. Genetic diversity (e.g. using seed grown material) and careful provenance selection for better adapted selections of the same species should be considered to provide additional protection from the effects of climate change (Aitken, Yeaman et al. 2008, Lohr 2013). There are also risks with new species selection leading to reduced diversity at larger scales. For example, if locally indigenous trees are replaced with cosmopolitan species, diversity at regional and global scales may decline even while diversity at local scales is maintained or increased.

3) Another important criterion for selecting future species is risk of naturalization and spread into native vegetation. New species should be assessed for weed risk under current and future climates.
4) Managers will also need to be aware of maladaptation and feedback loops. Some obvious adaptation strategies, such as the use of more heat and drought-tolerant species, can in fact exacerbate the local effects of climate change. For example, where replacement tree species have much sparser canopies than those they are replacing, there could be an increase in the urban heat island effect. More trees may be required to ensure no net-loss in canopy cover. Moreover, policy responses to drought in south-eastern Australia have included restricting the availability of irrigation water for the urban forest (MacDonald, Crossman et al. 2010). This could hasten the negative effects of climate change on vulnerable species, and reduce the supply of important ecosystem services such as cooling.

Actions taken need to consider the multiple benefits provided by individual trees and suites of species. The decisions managers make should be guided by an understanding of the ecosystem services, biodiversity, habitat, social and cultural values of the urban forest and needs to ensure the urban forest meets the diverse needs of both humans and non-human animals into the future.

Urban Forest Diversity

Lyndal Plant

A wide variation in abundance and frequency of street trees between east coast Australian cities, irrespective of existing climate has been reported (Kirkpatrick et al 2011). The results of this study also reveal wide variation in species richness, diversity and consequent vulnerability to future urban climate scenarios between LGAs across Australia, and between LGAs in the same city. For example, the number of species that make up 50% of the inventoried population of trees, across all 28 LGAs varied from 2 to 23, and the proportion of those species assessed as at least moderately at risk in the emissions limited climate scenario varied between zero and 100%. Within the Greater Melbourne area, between 11 and 23 species made up 50% of the 10 inventoried tree populations, of which between 12% and 64% were at least moderately at risk in the emissions limited climate future scenario. Heterogeneity of both street tree abundance and diversity within Australian cities may be similarly influenced by pre-urban vegetation types, eras of development and planting styles (Williams 2002) and local-government decision-making (Kirkpatrick et al 2011; Plant and Sipe 2016).

More importantly, risk from increasing temperatures was not consistently lower in LGAs with higher species richness. While low species diversity in urban tree populations is more clearly associated with greater vulnerability to injury from biotic and abiotic stresses and catastrophic loss of trees and the ecosystem services they provide (Kendal et al 2014), this study reinforces the idea that greater species diversity alone does not translate to greater resilience to future changes in urban climate in Australia. Improving resilience is dependent on the ability to screen species for their tolerance of current and future biotic and abiotic conditions.

Implications for management

The technique demonstrated in this study advances the development of species screening tools for LGAs. In particular, LGAs can benefit from knowledge about the species with greater heat resilience that may currently be less well represented, but already satisfying other performance and functional criteria.

Species screening must also take place within the context of other locally relevant urban forest goals. For example, Brisbane's street population has been reported as extensive and diverse, supported by both subtropical climate and history of low density development and pre-urban forest cover, yet also reported as a population transitioning away from larger growing tree species towards a limited mix of small-medium sized native evergreen species. It has already been suggested that such transition may reduce the capacity to achieve footpath tree canopy cover targets (Plant and Sipe 2016). Results of this study suggest that such transition may also increase vulnerability of the street tree population to changing climate.

Table 6 – Diversity of LGAs urban forests, and the risk of temperature increases on common species

LGA	METROPOLITAN AREA	# SPECIES MAKING UP 50% TREE POPULATION	# OF THESE WITH MODERATE RISK IN EMISSIONS LIMITED CLIMATE FUTURE
City of Burnside	Adelaide	7	1
City of Adelaide	Adelaide	4	4
City of Prospect	Adelaide	3	0
City of Ballarat	Ballarat	13	0
City of Brisbane	Brisbane	11	1
Corangamite Shire	Camperdown etc	14	2
Canberra	Canberra	7	0
Colac-Otway Shire	Colac etc.	7	0
City of Darwin	Darwin	2	2
City of Greater Geelong	Geelong	9	0
Southern Grampians Shire	Hamilton etc.	9	3
City of Launceston	Launceston	18	1
Brimbank	Melbourne	23	2
City of Casey	Melbourne	14	1
City of Melbourne	Melbourne	13	6
Hobsons Bay City Council	Melbourne	15	1
Hume City Council	Melbourne	17	0
Manningham City Council	Melbourne	15	2
Maroondah City Council	Melbourne	12	2
Moonee Valley	Melbourne	11	3
Moreland City Council	Melbourne	11	1
City of Whittlesea	Melbourne	14	0
City of Perth	Perth	10	5
City of Fremantle	Perth	10	6
Glenelg Shire	Portland etc.	5	0
Greater Shepparton City Council	Shepparton	14	5
City of Sydney	Sydney	10	6
Marrickville	Sydney	10	4
City of Townsville	Townsville	9	3

Ecosystem Services

Dave Kendal & Alison Farrar

Urban areas that are well planned can be major providers of ecosystem services of local and regional value (Dobbs *et al.*, 2017). Trees in urban landscapes provide of a range of ecosystem services including climate amelioration, removing air pollution, slowing stormwater by intercepting rainfall, and providing quality areas for recreation (Dobbs, Escobedo et al. 2011). Urban trees can also provide disservices (e.g. pollen allergies, emissions of biogenic volatile organic compounds).

The provision of ecosystem services depends on both the supply of services from the urban forest, and the demand for services from people. Supply is the potential of an ecosystem to provide a given ecosystem service, and demand is the level of service provision desired or required by people (Dobbs et al., 2017). Changes in climate under future climate scenarios is likely to affect both the supply of and the demand for ecosystem services. For example, the demand for urban trees to provide cooling and shade will likely be influenced by the climate of the city.

Implications for managers

- To understand the provision of ecosystem services, supply can be mapped (Dobbs et al., 2014). These maps can then be compared with maps of temperature risk or socioeconomics to identify priority areas for management (e.g. high risk areas that are also important suppliers of ecosystem services)
- Understanding the demand for ecosystem services can use a range of tools and techniques. ABS Census data can be used to map areas of social vulnerability (e.g. proportion of elderly people who may be more vulnerable to urban heat). Community consultation and engagement activities can be used to understand the values and preferences of the community.
- Ecosystem service assessments can be included in decision-making around tree removal and new species selection. The can help avoid maladaptation, where selection of species adapted to heat and drought may have characteristics (e.g. narrow leaves) that can cause feedback loops that lower supply of cooling and in-turn increase urban heat (Kendal & McDonnell, 2014)
- Consider mechanisms to improve the supply of ecosystem services from the existing forest. For example, irrigating trees can lead to increases in the provision of cooling (Norton et al., 2013).

Biodiversity

Caragh G. Threlfall

Increased risk to tree health and survival under increased urban temperatures will lead to changes in the composition, structure and configuration of the urban forest. Changes of this sort are likely to significantly influence urban fauna communities, although the extent to which this occurs is under-studied.

Significant changes in the composition of the urban forest will lead to corresponding changes in the insect, mammal, bird and bat communities found within specific LGA's. For example, streetscapes with >30 % mature *Eucalypt* canopy support a greater array of native Australian bird species than exotic streetscapes (Ikin, Knight et al. 2013). Additionally, green spaces (parks, golf courses and residential streets) that contain native trees > 80cm diametre support greater breeding activity of native, rather than exotic, bird species (Threlfall, Williams et al. 2016). The flight activity of

insectivorous microbats is also high in green spaces with large native trees (Threlfall, Williams et al. 2016), presumably due to the positive influence of native vegetation on insects, which form the basis of the diet for many native mammals, birds and bat species. These studies suggest that to reduce the impact of significant changes in the urban forest on biodiversity, the proportion of the canopy that is native or exotic should be considered.

The physical structure of trees also affects urban fauna. Trees in a state of advanced senescence (from natural causes, or in this case, due to decreased tree health with increasing urban temperatures) often provide cavities, decayed wood and hollows, which are features that are highly utilized by a range of fauna. However, these types of trees will not provide other features such as new leaf material, flowers and fruits, which provides high quality forage for a variety of taxa.

The most dominant ecological interaction occurring in urban landscapes is between insect herbivores and plants, specifically urban trees. Alarmingly, urban trees in some cities are predicted to suffer a significant increase in damage from insect herbivores as urbanisation proceeds. Increased herbivore damage may be caused by increased urban temperatures, which allow certain insect species to complete their life cycle faster, or due to decreased insect control due to the scarcity of natural predators, such as predatory and parasitic insects, insectivorous birds and bats (Meineke, Dunn et al. 2013, Dale and Frank 2014). Increased insect herbivore damage will compromise the services and resilience trees provide, and as such should be closely monitored, especially in areas and for tree species identified as high risk.

Lastly, the distribution of trees and aggregation of trees identified as high risk is likely to influence urban biodiversity. Isolated trees provide stepping stone habitat in many human-modified landscapes, and groups of trees likely provide important refugia for many animals. The spatial location of trees identified as high risk is important, as loss of such trees may have increased biodiversity impacts if they are located in areas that would otherwise support high levels of biodiversity (e.g. near reserves, along waterways, or in green spaces considered to support high biodiversity values).

Implications for managers

- Tree renewal initiatives designed to replace dead or dying trees should consider using species that ensure the replacement of lost resources (e.g. fruits, seeds, nectar, hollows, shedding bark) that certain species of tree provide.
- Plan to create stepping stone habitat or refugia for fauna, linking key areas of high biodiversity value. This is especially important in the event that trees at high risk are spatially co-located, increasing the impact of their loss.
- Monitor levels of herbivory across the range of tree species present and investigate the use of tree species less prone to herbivory in future plantings.
- Consider options for improving non-tree habitat (e.g. understorey plantings) where possible to provide habitat for natural predators of herbivores (insectivorous birds, bats and many types of invertebrates).

Social and cultural services

Alison Farrar

Urban trees are widely understood as ‘improving’ cities by increasing amenity and providing places for both passive and active recreation. Changes in species composition due to changing climates will have flow-on effects for the urban public and local communities. The effect of changing species composition and ‘trait’ shifts (e.g. in canopy density, colour, leaf width) on the provision of cultural and heritage values and local communities sense of place is potentially very important. In some places, trees with European and/or Indigenous cultural values are disproportionately at risk. Sustaining the quality of urban trees requires ongoing community involvement.

Socioeconomic status is an important driver of urban greening in public landscapes in Australia and around the world (Iverson and Cook, 2000; Luck et al., 2009). Some research from the USA suggests that this is the result of a 'luxury effect', where people with the 'economic wherewithal' are able to move to areas with more vegetation, or plant more vegetation themselves (e.g. Martin et al., 2004). However, there is evidence that this phenomena is being driven by top-down processes where advantaged sections of the community have the capacity to influence the provision of public goods (e.g. street trees) for private gain (Kendal, Williams et al. 2012). The risk of the urban forest to future climate is also likely to be distributed unequally, therefore inequality is likely to be reinforced through changing climates.

Management implications

Management and planning of the urban forests should aim to incorporate social services and cultural and heritage values into planning. Actions that managers can take to help achieve this includes engaging with communities and considering equity in the current and future urban forest.

Engage with communities

Community outreach is needed to maximize public and stakeholder awareness around threats to urban forests and the required changes in urban forest management in response to projected climate change. Education material detailing why changes in tree species plantings are needed, best urban forest management practices for tree conservation and associated ecosystem services, and when and how this will be implemented could be provided to residents in areas planning change.

Consultation and cooperation with stakeholder groups such as local indigenous groups, conservation groups, and Friends groups (e.g. heritage groups such as Friends of the Elms) will be important in encouraging community partners to embrace changes to management of the urban forest. Moreover, collaborations with the nursery industry on initiatives such as planting incentive programs (where trees on the green list are discounted at local nurseries for instance) may foster urban forest stewardship by engaging residents and business owners to plant suitable trees on private land.

Consider heritage and cultural values of local communities

Among the most important flow on effect of trait shifts of urban trees will involve people's perceptions and experience of the urban forest. Trees are an important component of the sense of place of cities. Many cities in south-eastern Australia have a strong European colonial heritage expressed in their many broad- leaved deciduous trees that is likely to change under future climates. Conversely, the local native trees planted in a city help to create a unique identity that distinguishes one city from another, and provides an important connection to the regions natural heritage and traditional owenership by indigenous people. Changes to the composition and the traits of the urban forest will lead to changes in the sense of place and identity of cities. Recognizing the importance of trait shifts as a result of this adaptation will allow managers to plan for a healthy urban forest that satisfies cultural and natural heritage needs.

Consider socioeconomic equality in current and future planning

There are potentially large benefits in greening disadvantaged areas. For example, health inequalities have been shown to be smaller in green areas (Mitchell and Popham, 2008). Trees and green spaces may provide proportionally greater benefits in disadvantaged areas. In Australia, a number of studies have identified education level rather than income as a better predictor of the distribution of urban greenery (Kendal et al., 2012a; Luck et al., 2009). This reinforces the idea that factors other than personal economic ones are important in people's thinking about urban green spaces. Considering equity of the quantity, quality and provision of management is important when planning for the current and future urban forests.

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LGA Profiles

Brimbank City Council, Melbourne	22
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City of Fremantle	38
City of Greater Geelong	40
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City of Melbourne	44
City of Perth	46
City of Prospect, Adelaide	48
City of Sydney	50
City of Townsville	52
City of Whittlesea, Melbourne	54
Colac-Otway Shire, Victoria	56
Corangamite Shire, Victoria	58
Glenelg Shire Council, Victoria	60
Greater Shepparton City Council	62
Hobsons Bay City Council, Melbourne	64
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Victoria	

Brimbank City Council, Melbourne

Number of species in dataset: 657
Number of species assessed: 635 (96.7%)
Number of trees in dataset: 180,139
Number of trees assessed: 143,024 (79.4%)

Table 7: The proportion of Brimbank's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	67%	10%	2%	1%	69%	13%	9%	9%
Emissions limited (RCP4.5 2040)	48%	19%	10%	3%	40%	23%	19%	18%
Business as usual (RCP8.5 2070)	16%	23%	7%	12%	24%	14%	23%	40%

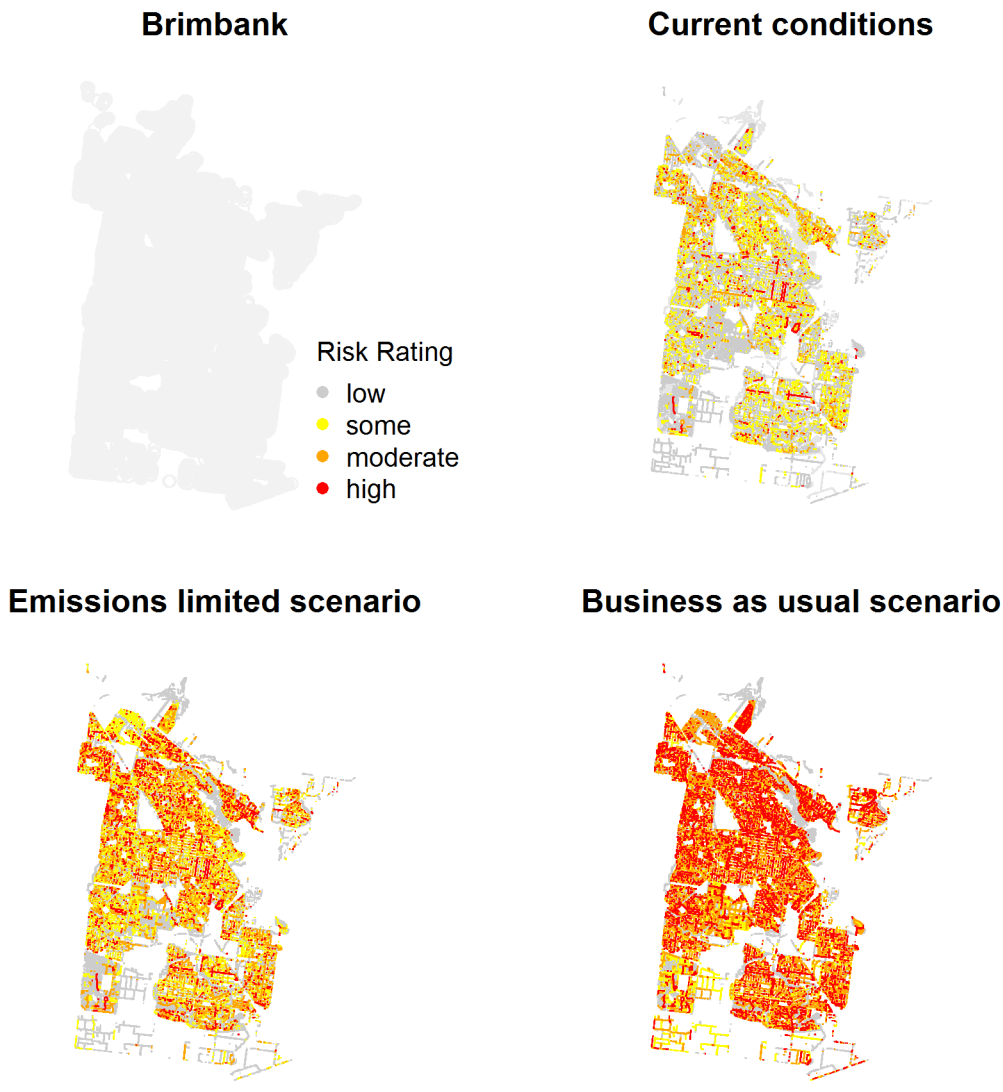

Figure 7: Risk to individual trees within Brimbank's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 8: Temperature risk of the most common species in Brimbank.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	Unknown		36468			
2	*Pyrus calleryana*	4.53%	6485	green	green	yellow
3	*Corymbia maculata*	4.43%	6343	green	green	yellow
4	*Eucalyptus leucoxylon*	4.39%	6278	green	green	orange
5	*Eucalyptus cladocalyx*	4.03%	5766	green	green	orange
6	*Melia azedarach*	2.67%	3815	green	green	green
7	*Eucalyptus sideroxylon*	2.51%	3589	green	green	yellow
8	*Agonis flexuosa*	2.26%	3238	green	yellow	orange
9	*Angophora costata*	2.19%	3134	green	green	orange
10	*Melaleuca armillaris*	2.10%	2997	green	green	orange
11	*Fraxinus angustifolia*	2.06%	2947	green	orange	orange
12	*Callistemon viminalis*	1.91%	2737	green	green	green
13	*Lophostemon confertus*	1.90%	2711	green	green	green
14	*Prunus cerasifera*	1.75%	2509	yellow	yellow	orange
15	*Eucalyptus camaldulensis*	1.71%	2447	green	green	green
16	*Platanus acerifolia*	1.69%	2412	green	yellow	orange
17	*Cupressus × leylandii*	1.67%	2387	green	yellow	orange
18	*Allocasuarina verticillata*	1.56%	2231	green	green	yellow
19	*Callistemon salignus*	1.51%	2153	green	green	green
20	*Eucalyptus melliodora*	1.46%	2094	green	yellow	red
21	*Olea europaea*	1.37%	1960	green	green	yellow
22	*Melaleuca linariifolia*	1.27%	1819	green	green	yellow
23	*Eucalyptus scoparia*	1.27%	1816	green	orange	red
24	*Acacia implexa*	1.24%	1775	green	yellow	orange
25	*Corymbia ficifolia*	1.20%	1715	green	yellow	orange
26	*Melaleuca styphelioides*	1.15%	1638	green	green	yellow
27	*Corymbia citriodora*	1.14%	1626	green	green	green
28	*Callistemon citrinus*	1.10%	1570	green	green	green
29	*Pittosporum undulatum*	1.10%	1569	green	green	orange
30	*Eucalyptus microcarpa*	1.07%	1535	green	yellow	orange
31	*Eucalyptus nicholii*	1.03%	1467	green	yellow	orange
32	*Ulmus parvifolia*	1.01%	1450	green	green	green
33	*Lagerstroemia indica*	0.99%	1420	green	green	green
34	*Acacia melanoxylon*	0.95%	1365	green	yellow	orange
35	*Tristaniopsis laurina*	0.94%	1341	green	green	yellow
36	*Betula pendula*	0.94%	1341	orange	red	red
37	*Eucalyptus mannifera*	0.90%	1288	yellow	orange	red
38	*Cupressus macrocarpa*	0.79%	1130	green	green	yellow
39	*Callistemon spp.*	0.77%	1105	green	green	green
40	*Eucalyptus spp.*	0.75%	1075	green	yellow	orange
41	*Robinia pseudoacacia*	0.73%	1048	yellow	orange	orange
42	*Eucalyptus polyanthemos*	0.73%	1043	green	yellow	orange
43	*Platanus orientalis*	0.67%	955	green	green	green
44	*Corymbia eximia*	0.65%	924	green	yellow	red
45	*Eucalyptus sargentii*	0.64%	910	green	green	yellow
46	*Hakea salicifolia*	0.63%	897	green	yellow	orange
47	*Pittosporum tenuifolium*	0.57%	817	yellow	orange	red
48	*Casuarina cunninghamiana*	0.55%	780	green	green	green
49	*Acacia mearnsii*	0.54%	769	green	orange	red
50	*Lagunaria patersonia*	0.49%	699	green	green	yellow

Brisbane City Council

Number of species in dataset: 182
Number of species assessed: 148 (81.3%)
Number of trees in dataset: **9,098**
Number of trees assessed: **8,424 (92.6%)**

Table 9: The proportion of Brisbane's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	67%	16%	8%	3%	59%	18%	15%	9%
Emissions limited (RCP4.5 2040)	38%	35%	9%	14%	43%	19%	14%	24%
Business as usual (RCP8.5 2070)	31%	13%	24%	19%	31%	17%	14%	38%

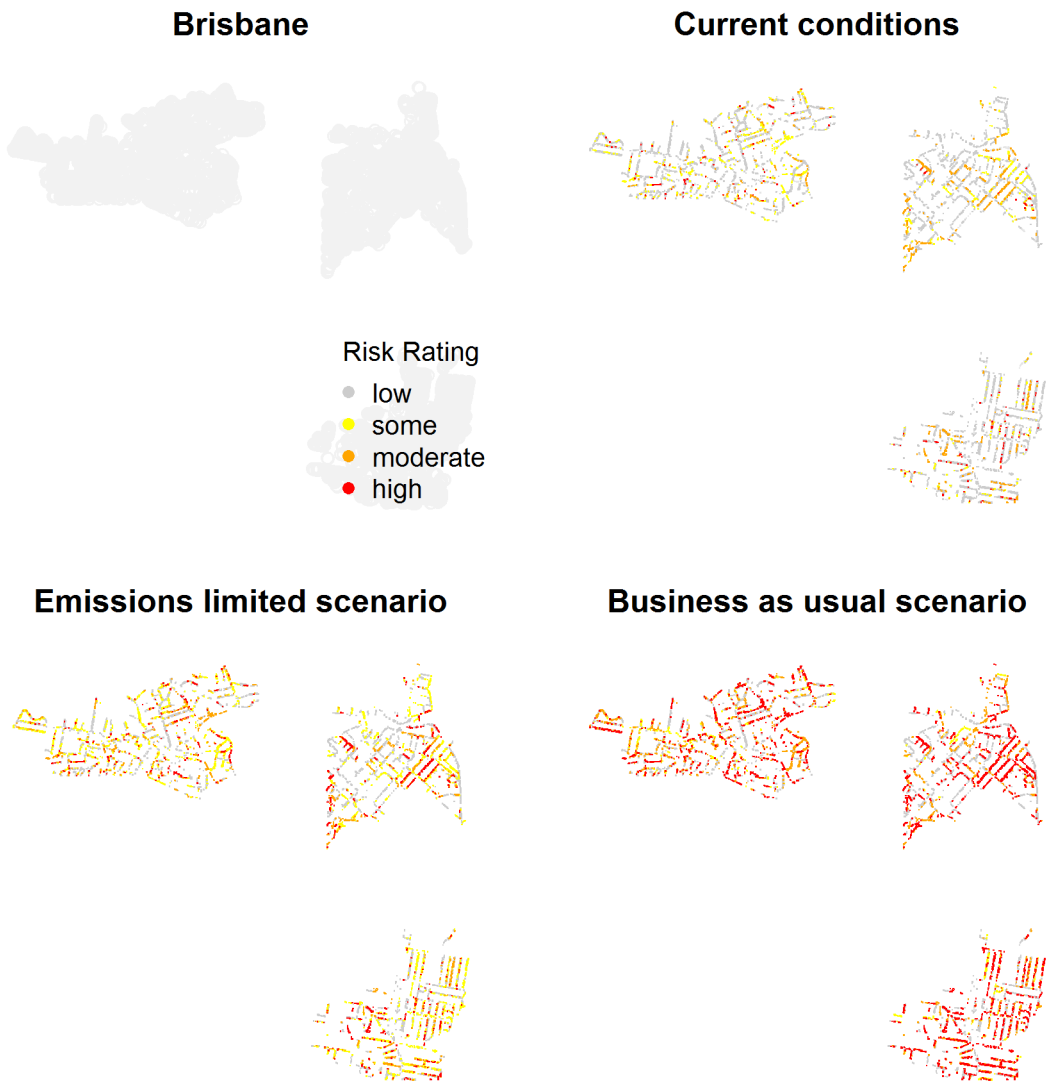

Figure 8: Risk to individual trees within Brisbane's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 10: Temperature risk of the most common species in Brisbane.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Harpullia pendula*	11.7%	987	green	yellow	orange
2	*Caesalpinia ferrea*	6.5%	546	green	green	green
3	*Buckinghamia celsissima*	5.2%	436	green	yellow	orange
4	*Cupaniopsis anacardioides*	4.6%	391	green	green	green
5	*Xanthostemon chrysanthus*	4.4%	367	green	green	yellow
6	*Callistemon viminalis*	4.1%	343	green	yellow	yellow
7	*Unknown*		332			
8	*Jacaranda mimosifolia*	3.8%	320	green	yellow	orange
9	*Delonix regia*	3.8%	317	green	green	green
10	*Syzygium luehmannii*	2.9%	242	yellow	yellow	orange
11	*Flindersia spp.*	2.6%	215	yellow	orange	red
12	*Syzygium australe*	2.1%	177	orange	red	red
13	*Melaleuca leucadendra*	2.1%	174	green	green	green
14	*Flindersia australis*	1.9%	163	yellow	red	red
15	*Ficus spp.*	1.9%	160	green	green	green
16	*Syzygium spp.*	1.9%	156	yellow	orange	red
17	*Koelreuteria paniculata*	1.6%	131	orange	red	red
18	*Syzygium floribundum*	1.5%	130	yellow	orange	orange
19	*Peltophorum pterocarpum*	1.5%	129	green	green	green
20	*Lophostemon confertus*	1.5%	124	orange	red	red
21	*Agathis robusta*	1.3%	113	green	green	orange
22	*Schotia brachypetala*	1.3%	107	green	yellow	red
23	*Flindersia schottiana*	1.2%	101	yellow	yellow	orange
24	*Senna siamea*	1.2%	101	green	green	green
25	*Tamarindus indica*	1.1%	94	green	green	green
26	*Araucaria cunninghamii*	1.0%	85	green	yellow	yellow
27	*Brachychiton acerifolius*	1.0%	84	orange	red	red
28	*Melaleuca quinquenervia*	1.0%	83	green	yellow	orange
29	*Tabebuia spp.*	1.0%	82	green	green	green
30	*Tabebuia rosea*	0.9%	79	green	green	green
31	*Tabebuia aurea*	0.9%	73	green	green	green
32	*Fraxinus spp.*		69			
33	*Grevillea robusta*	0.8%	69	green	yellow	orange
34	*Bauhinia variegata*	0.8%	67	green	green	yellow
35	*Pongamia pinnata*	0.8%	66	green	green	green
36	*Callistemon salignus*	0.7%	62	red	red	red
37	*Callistemon spp.*	0.7%	59	yellow	yellow	orange
38	*Melaleuca spp.*	0.7%	58	yellow	yellow	yellow
39	*Plumeria spp.*	0.7%	58	green	green	green
40	*Eucalyptus spp.*	0.6%	53	orange	red	red
41	*Spathodea campanulata*	0.6%	51	green	green	green
42	*Lagerstroemia indica*	0.6%	50	green	green	yellow
43	*Corymbia ptychocarpa*	0.6%	48	green	green	green
44	*Grevillea baileyana*	0.6%	47	green	green	green
45	*Ficus benjamina*	0.5%	46	green	green	green
46	*Melaleuca linariifolia*	0.5%	46	red	red	red
47	*Syagrus romanzoffiana*	0.5%	46	green	orange	red
48	*Elaeocarpus eumundi*	0.5%	42	green	yellow	orange
49	*Archontophoenix alexandrae*	0.5%	41	green	green	yellow
50	*Celtis sinensis*	0.5%	41	yellow	orange	red

Canberra

Number of species in dataset: 323
Number of species assessed: 306 (94.7%)
Number of trees in dataset: **446,730**
Number of trees assessed: **356,547 (79.8%)**

Table 11: The proportion of Canberra's urban forest at risk in future temperatures.

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	66%	14%	0%	0%	77%	12%	9%	2%
Emissions limited (RCP4.5 2040)	46%	29%	6%	0%	54%	17%	17%	12%
Business as usual (RCP8.5 2070)	20%	28%	7%	5%	29%	22%	21%	28%

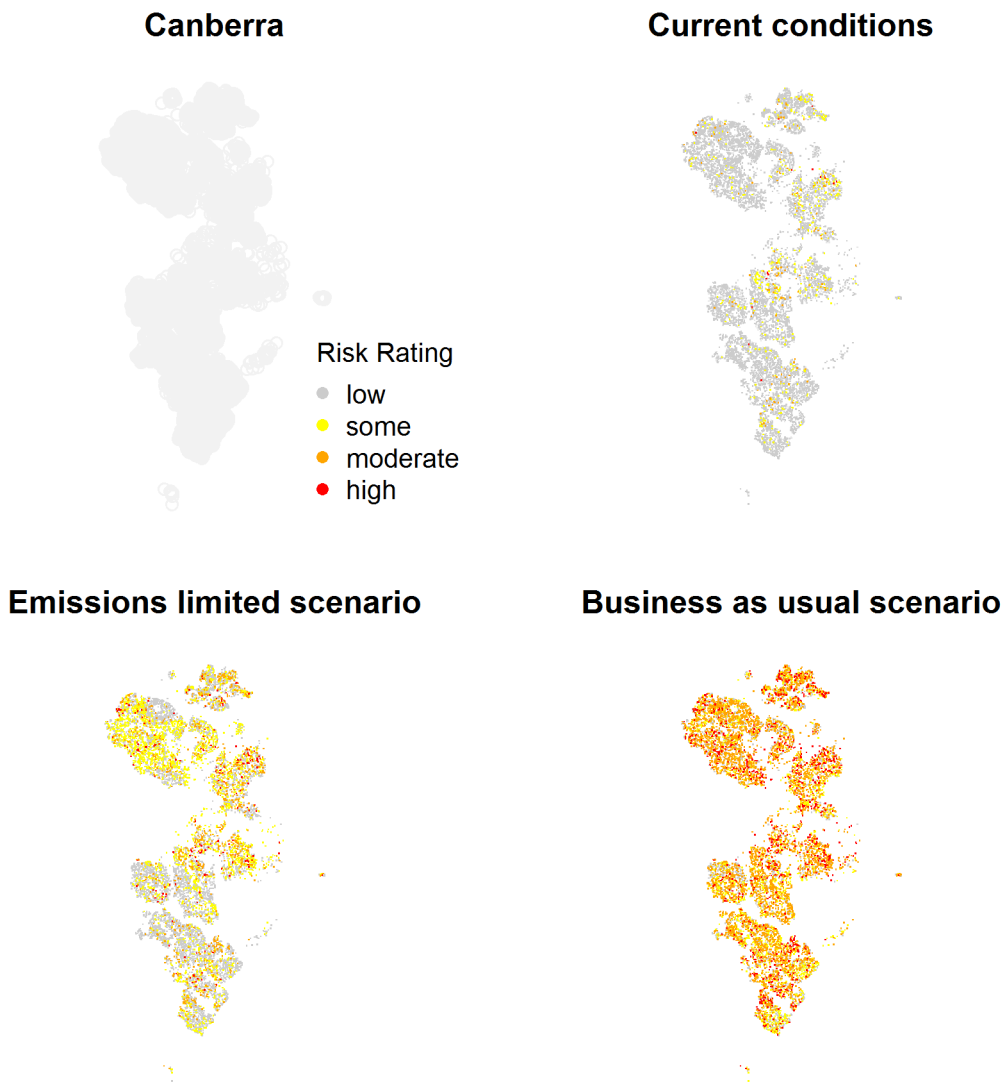

Figure 9: Risk to individual trees within Canberra's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 12: Temperature risk of the most common species in Canberra.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	Unknown		87388			
2	*Eucalyptus mannifera*	16.50%	58813	green	green	orange
3	*Eucalyptus spp.*	9.95%	35494	green	green	yellow
4	*Casuarina cunninghamiana*	9.89%	35251	green	green	green
5	*Eucalyptus polyanthemos*	5.12%	18244	green	green	yellow
6	*Eucalyptus melliodora*	5.00%	17814	green	green	yellow
7	*Pinus radiata*	3.67%	13090	green	yellow	orange
8	*Fraxinus angustifolia*	3.27%	11651	green	green	orange
9	*Pyrus calleryana*	2.34%	8339	green	green	green
10	*Quercus palustris*	2.27%	8084	green	orange	orange
11	*Eucalyptus blakelyi*	2.15%	7656	green	green	yellow
12	*Eucalyptus cinerea*	2.12%	7542	green	green	yellow
13	*Eucalyptus sideroxylon*	2.09%	7445	green	green	green
14	*Populus alba*	1.84%	6549	green	yellow	orange
15	*Ulmus parvifolia*	1.63%	5794	green	green	green
16	*Eucalyptus globulus*	1.52%	5425	green	green	green
17	*Prunus cerasifera*	1.46%	5194	green	yellow	yellow
18	*Eucalyptus nicholii*	1.41%	5044	green	green	yellow
19	*Quercus spp.*	1.35%	4809	green	yellow	orange
20	*Liquidambar styraciflua*	1.17%	4176	green	green	green
21	*Gleditsia triacanthos*	1.17%	4166	green	green	yellow
22	*Zelkova serrata*	1.02%	3642	green	green	green
23	*Populus spp.*	0.99%	3536	green	yellow	orange
24	*Platanus acerifolia*	0.94%	3340	green	green	yellow
25	*Ulmus minor*	0.93%	3299	green	yellow	red
26	*Pistacia chinensis*	0.88%	3139	green	green	green
27	*Quercus lusitanica*	0.84%	3010	green	green	orange
28	*Ulmus spp.*	0.73%	2601	green	yellow	orange
29	*Platanus orientalis*	0.68%	2441	green	green	green
30	*Eucalyptus viminalis*	0.65%	2331	green	yellow	orange
31	*Celtis australis*	0.64%	2295	green	green	yellow
32	*Eucalyptus bridgesiana*	0.59%	2099	green	orange	red
33	*Fraxinus spp.*	0.58%	2051	green	green	orange
34	*Cedrus atlantica*	0.54%	1941	green	orange	orange
35	*Styphnolobium japonicum*	0.53%	1880	green	green	yellow
36	*Pinus spp.*	0.53%	1878	green	yellow	orange
37	*Pyrus ussuriensis*	0.51%	1836	green	green	yellow
38	*Cupressus spp.*	0.46%	1632	green	green	green
39	*Fraxinus velutina*	0.43%	1526	green	green	green
40	*Quercus robur*	0.43%	1523	yellow	orange	orange
41	*Eucalyptus elata*	0.42%	1510	green	green	orange
42	*Ulmus × hollandica*	0.40%	1426	yellow	orange	red
43	*Cupressus sempervirens*	0.37%	1314	green	green	green
44	*Quercus cerris*	0.35%	1243	yellow	yellow	orange
45	*Eucalyptus macrorhyncha*	0.34%	1229	green	yellow	red
46	*Populus nigra*	0.34%	1212	green	yellow	yellow
47	*Platanus spp.*	0.32%	1145	green	green	yellow
48	*Ulmus americana*	0.29%	1021	green	yellow	yellow
49	*Fraxinus americana*	0.28%	1001	green	yellow	yellow
50	*Quercus canariensis*	0.28%	992	green	green	yellow

City of Burnside, Adelaide

Number of species in dataset: 315
Number of species assessed: 306 (97.1%)
Number of trees in dataset: **34,016**
Number of trees assessed: **33,432 (98.3%)**

Table 13: The proportion of Burnside's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	73%	11%	13%	2%	54%	22%	17%	8%
Emissions limited (RCP4.5 2040)	43%	27%	14%	16%	31%	17%	26%	26%
Business as usual (RCP8.5 2070)	32%	16%	6%	22%	20%	16%	18%	45%

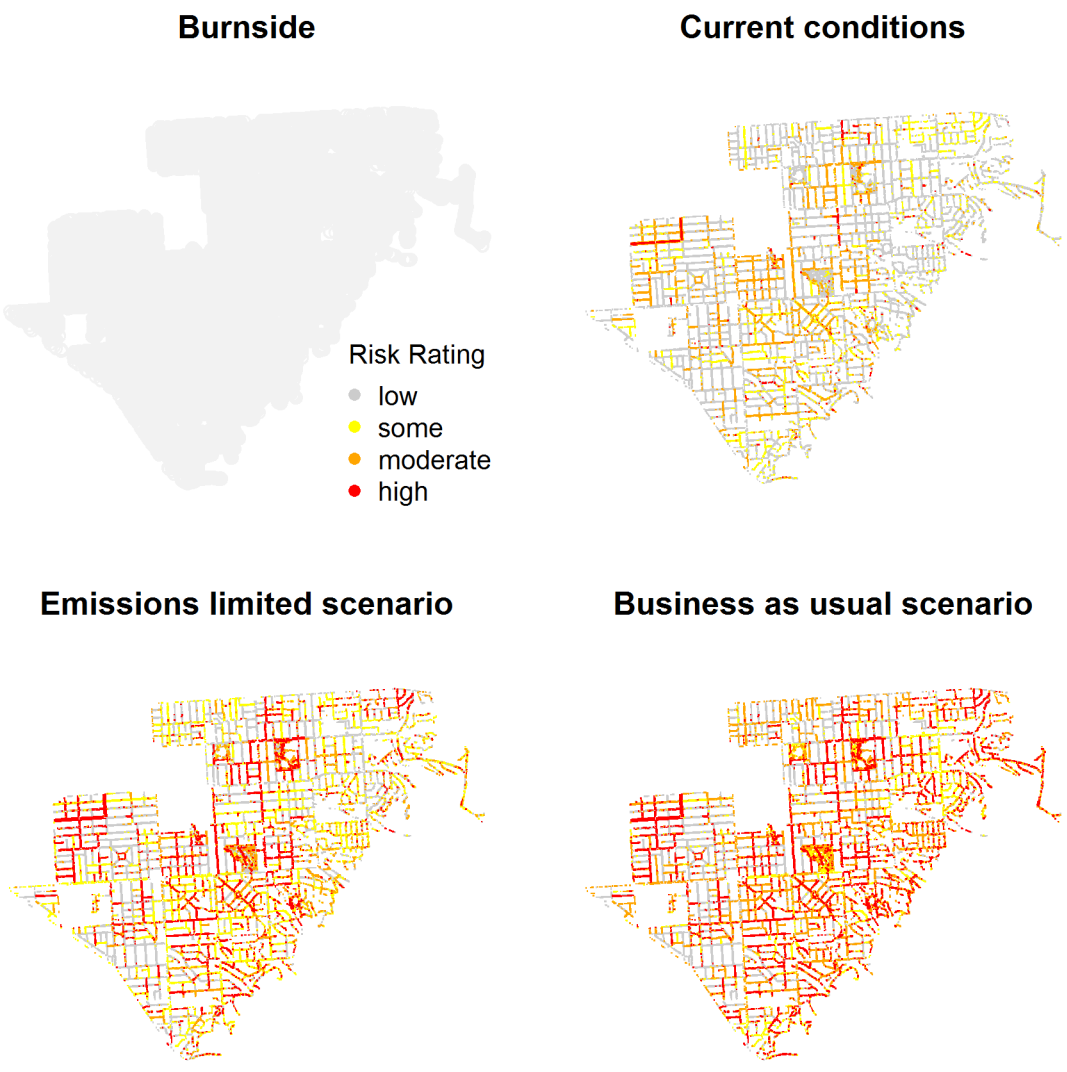

Figure 10: Risk to individual trees within Burnside's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 14: Temperature risk of the most common species in Burnside.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Jacaranda mimosifolia*	14.32%	4789	green	green	green
2	*Lophostemon confertus*	8.76%	2929	green	yellow	orange
3	*Fraxinus angustifolia*	7.00%	2339	orange	red	red
4	*Melia azedarach*	6.15%	2056	green	green	green
5	*Pyrus calleryana*	5.66%	1892	green	yellow	orange
6	*Eucalyptus camaldulensis*	5.08%	1699	green	green	yellow
7	*Eucalyptus leucoxylon*	4.32%	1443	green	yellow	orange
8	*Koelreuteria paniculata*	3.42%	1145	yellow	yellow	orange
9	*Agonis flexuosa*	2.88%	962	yellow	orange	red
10	*Prunus × blireiana*	1.93%	645	orange	red	red
11	*Callistemon viminalis*	1.90%	635	green	green	green
12	*Prunus cerasifera*	1.75%	586	orange	orange	orange
13	*Cupaniopsis anacardioides*	1.55%	519	green	green	green
14	*Lagerstroemia indica*	1.47%	490	green	green	green
15	*Corymbia citriodora*	1.40%	467	green	green	green
16	*Brachychiton populneus*	1.35%	452	green	yellow	yellow
17	*Pistacia chinensis*	1.26%	421	green	green	yellow
18	*Ulmus parvifolia*	1.25%	417	green	yellow	yellow
19	*Eucalyptus microcarpa*	1.23%	411	yellow	orange	red
20	*Olea europaea*	1.20%	402	green	yellow	yellow
21	*Celtis australis*	1.20%	401	yellow	orange	red
22	*Fraxinus pennsylvanica*	1.17%	391	orange	orange	orange
23	*Corymbia maculata*	1.08%	361	green	orange	orange
24	*Ulmus minor*	0.93%	312	red	red	red
25	*Platanus acerifolia*	0.85%	283	orange	orange	orange
26	*Quercus robur*	0.79%	263	orange	red	red
27	*Eucalyptus cladocalyx*	0.77%	259	green	orange	red
28	*Gleditsia triacanthos*	0.77%	257	yellow	orange	orange
29	*Pinus halepensis*	0.74%	248	green	yellow	yellow
30	*Allocasuarina verticillata*	0.66%	219	green	yellow	orange
31	*Corymbia ficifolia*	0.63%	212	yellow	orange	orange
32	*Melaleuca armillaris*	0.56%	188	green	orange	red
33	*Harpullia pendula*	0.54%	179	green	green	green
34	*Callistemon spp.*	0.50%	166	green	green	green
35	*Cupressus sempervirens*	0.48%	162	green	green	yellow
36	*Citharexylum spinosum*	0.48%	159	green	green	green
37	*Acacia pycnantha*	0.41%	136	yellow	red	red
38	*Fraxinus griffithii*	0.38%	128	green	green	green
39	*Eucalyptus spathulata*	0.34%	115	green	orange	red
40	*Eucalyptus globulus*	0.32%	107	green	yellow	yellow
41	*Grevillea robusta*	0.30%	99	green	green	green
42	*Quercus canariensis*	0.30%	99	yellow	red	red
43	*Brachychiton acerifolius*	0.28%	95	green	yellow	orange
44	*Hymenosporum flavum*	0.28%	95	green	green	yellow
45	*Callitris preissii*	0.28%	95	yellow	red	red
46	*Schinus molle*	0.27%	89	green	yellow	yellow
47	*Robinia pseudoacacia*	0.26%	88	orange	orange	red
48	*Syzygium paniculatum*	0.26%	87	yellow	orange	red
49	*Eucalyptus torquata*	0.26%	86	green	orange	red
50	*Eucalyptus sideroxylon*	0.22%	75	green	yellow	orange

City of Adelaide

Number of species in dataset: 65
Number of species assessed: 64 (98.5%)
Number of trees in dataset: 6,029
Number of trees assessed: 5,978 (99.2%)

Table 15: The proportion of Adelaide's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	25%	20%	54%	1%	50%	25%	19%	6%
Emissions limited (RCP4.5 2040)	13%	18%	26%	43%	23%	23%	25%	28%
Business as usual (RCP8.5 2070)	12%	2%	27%	43%	19%	11%	39%	31%

Figure 11: Risk to individual trees within Adelaide's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 16: Temperature risk of the most common species in the City of Adelaide.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Platanus acerifolia*	19.19%	1147	orange	orange	orange
2	*Celtis occidentalis*	17.31%	1035	orange	red	red
3	*Fraxinus angustifolia*	11.29%	675	orange	red	red
4	*Celtis australis*	9.70%	580	yellow	red	red
5	*Jacaranda mimosifolia*	7.44%	445	green	green	green
6	*Koelreuteria paniculata*	6.62%	396	yellow	yellow	orange
7	*Pyrus calleryana*	5.50%	329	green	yellow	orange
8	*Robinia pseudoacacia*	3.60%	215	orange	red	red
9	*Hymenosporum flavum*	2.99%	179	green	yellow	orange
10	*Lagerstroemia indica*	2.81%	168	green	green	green
11	*Ginkgo biloba*	2.17%	130	orange	orange	orange
12	*Lophostemon confertus*	1.92%	115	green	yellow	orange
13	*Gleditsia triacanthos*	1.51%	90	yellow	orange	orange
14	*Callistemon viminalis*	1.22%	73	green	green	green
15	*Platanus occidentalis*	1.04%	62	yellow	orange	orange
16	*Celtis laevigata*	0.79%	47	green	green	yellow
17	*Podocarpus elatus*	0.52%	31	green	yellow	yellow
18	*Eucalyptus leucoxylon*	0.50%	30	yellow	orange	orange
19	*Styphnolobium japonicum*	0.43%	26	yellow	orange	orange
20	*Ulmus minor*	0.43%	26	red	red	red
21	*Corymbia maculata*	0.37%	22	yellow	orange	orange
22	*Melia azedarach*	0.33%	20	green	green	green
23	*Malus spp.*		20			
24	*Prunus cerasifera*	0.22%	13	orange	orange	orange
25	*Washingtonia filifera*	0.20%	12	green	green	green
26	*Eucalyptus sideroxylon*	0.13%	8	green	orange	orange
27	*Betula pendula*	0.13%	8	red	red	red
28	*Callistemon spp.*	0.12%	7	green	green	green
29	*Pyrus ussuriensis**	0.12%	7	orange	red	red
30	*Olea europaea*	0.10%	6	green	yellow	orange
31	*Platanus orientalis*	0.10%	6	green	yellow	orange
32	*Ulmus parvifolia*	0.10%	6	green	yellow	yellow
33	*Eucalyptus camaldulensis*	0.07%	4	green	green	yellow
34	*Zelkova serrata*	0.07%	4	yellow	yellow	orange
35	*Allocasuarina verticillata*	0.05%	3	green	orange	orange
36	*Brachychiton populneus*	0.05%	3	green	yellow	yellow
37	*Citrus limon*	0.05%	3	green	green	green
38	*Eucalyptus spathulata*	0.05%	3	green	red	red
39	*Metrosideros excelsa*	0.05%	3	yellow	red	red
40	*Prunus spp.*	0.05%	3	orange	orange	orange
41	*Brachychiton acerifolius*	0.03%	2	green	orange	orange
42	*Corymbia citriodora*	0.03%	2	green	green	green
43	*Cupressus sempervirens*	0.03%	2	green	yellow	yellow
44	*Eucalyptus woodwardii*	0.03%	2	green	red	red
45	*Liquidambar styraciflua*	0.03%	2	green	yellow	orange
46	*Nerium oleander*	0.03%	2	green	green	green
47	*Pinus halepensis*	0.03%	2	green	yellow	orange
48	*Syagrus romanzoffiana*	0.03%	2	green	green	green
49	*Pyrus spp.*	0.03%	2	green	yellow	orange
50	*Cupressus macrocarpa*	0.03%	2	yellow	yellow	yellow

* likely to be *Pyrus calleryana*

City of Ballarat

Number of species in dataset: 242
Number of species assessed: 237 (97.9%)
Number of trees in dataset: 67,807
Number of trees assessed: 27,248 (40.2%)

Table 17: The proportion of Ballarat's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	36%	4%	0%	0%	89%	9%	1%	0%
Emissions limited (RCP4.5 2040)	21%	19%	1%	0%	78%	14%	8%	1%
Business as usual (RCP8.5 2070)	15%	15%	1%	1%	58%	18%	14%	10%

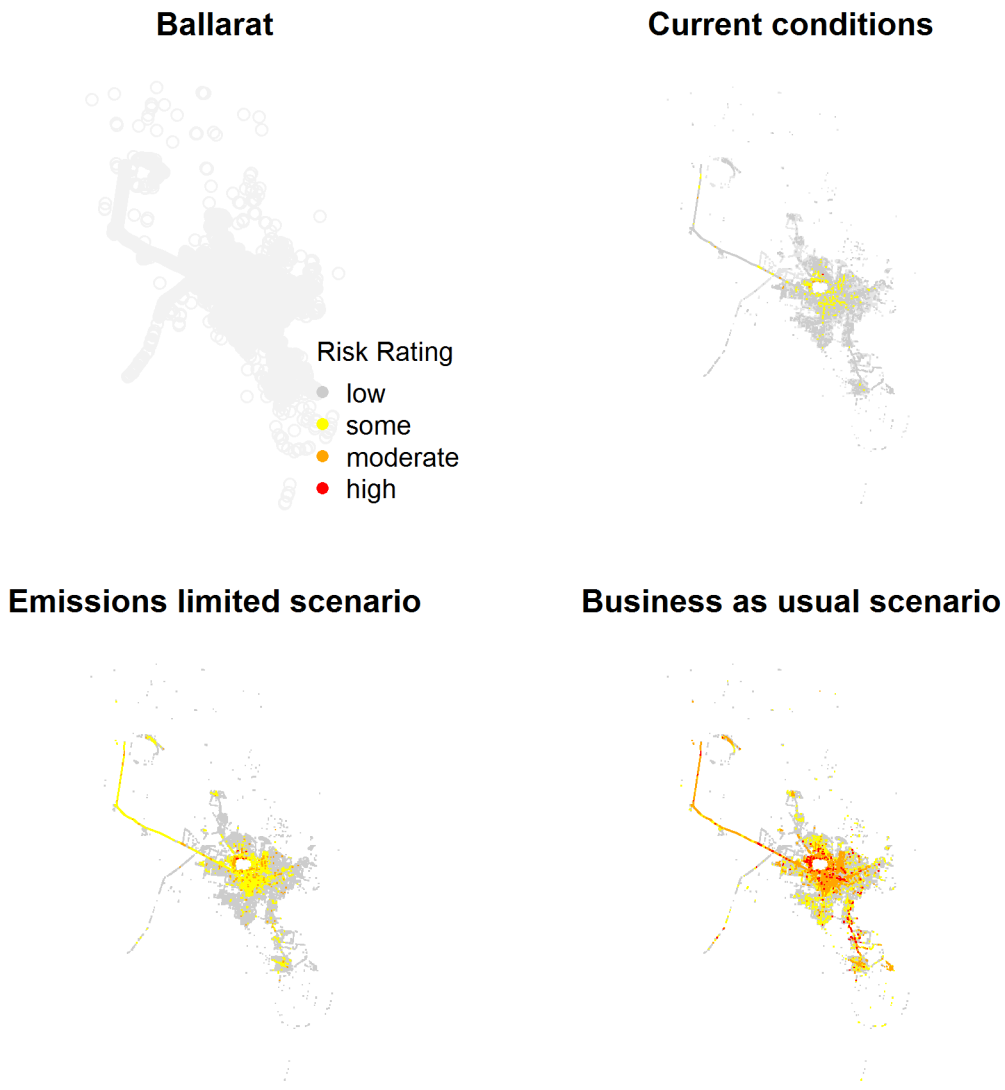

Figure 12: Risk to individual trees within Ballarat's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 18: Temperature risk of the most common species in Ballarat.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	Unknown					
2	*Ulmus × hollandica*	8.13%	2216	green	yellow	orange
3	*Quercus robur*	7.14%	1945	green	yellow	orange
4	*Eucalyptus spp.*	5.89%	1606	green	green	yellow
5	*Ulmus spp.*	5.75%	1568	green	yellow	orange
6	*Fraxinus spp.*	4.84%	1318	green	yellow	yellow
7	*Platanus acerifolia*	4.61%	1257	green	green	green
8	*Quercus palustris*	3.70%	1009	green	yellow	orange
9	*Populus alba*	2.40%	655	green	green	yellow
10	*Pyrus spp.*	2.25%	612	green	green	green
11	*Eucalyptus leucoxylon*	1.85%	504	green	green	green
12	*Fraxinus pennsylvanica*	1.78%	485	green	yellow	yellow
13	*Quercus cerris*	1.68%	458	green	yellow	yellow
14	*Acer buergerianum*	1.61%	439	green	green	green
15	*Acacia melanoxylon*	1.53%	416	green	green	green
16	*Fraxinus angustifolia*	1.48%	403	green	green	green
17	*Pyrus calleryana*	1.47%	401	green	green	green
18	*Pinus radiata*	1.43%	390	green	green	yellow
19	*Acer spp.*	1.31%	356	green	green	yellow
20	*Populus simonii*	1.28%	350	green	green	yellow
21	*Populus × canadensis*	1.25%	341	green	yellow	orange
22	*Ulmus parvifolia*	1.20%	328	green	green	green
23	*Callistemon spp.*	1.17%	318	green	green	green
24	*Platanus orientalis*	1.15%	313	green	green	green
25	*Prunus spp.*	1.02%	277	green	green	yellow
26	*Prunus cerasifera*	0.97%	264	green	green	yellow
27	*Lagerstroemia spp.*	0.97%	263	green	green	green
28	*Corymbia maculata*	0.94%	256	green	green	green
29	*Quercus spp.*	0.88%	241	green	yellow	orange
30	*Acacia spp.*	0.88%	240	green	green	green
31	*Cedrus deodara*	0.85%	232	green	green	yellow
32	*Eucalyptus scoparia*	0.82%	223	green	green	green
33	*Eucalyptus globulus*	0.80%	217	green	green	green
34	*Fraxinus americana*	0.76%	208	green	green	yellow
35	*Aesculus hippocastanum*	0.75%	205	yellow	yellow	orange
36	*Gleditsia triacanthos*	0.74%	202	green	green	green
37	*Angophora costata*	0.71%	194	green	green	green
38	*Eucalyptus nicholii*	0.71%	193	green	green	green
39	*Eucalyptus pauciflora*	0.69%	189	green	green	yellow
40	*Eucalyptus obliqua*	0.69%	187	green	green	orange
41	*Ulmus minor*	0.68%	186	green	yellow	orange
42	*Acer negundo*	0.66%	180	green	green	yellow
43	*Eucalyptus sideroxylon*	0.65%	177	green	green	green
44	*Cupressus macrocarpa*	0.61%	166	green	green	green
45	*Eucalyptus viminalis*	0.59%	161	green	green	yellow
46	*Fraxinus excelsior*	0.54%	148	yellow	orange	orange
47	*Lagerstroemia indica*	0.53%	145	green	green	green
48	*Populus nigra*	0.49%	134	green	green	yellow
49	*Corymbia ficifolia*	0.48%	130	green	green	green
50	*Callistemon viminalis*	0.47%	128	green	green	green

City of Casey, Melbourne

Number of species in dataset: 339
Number of species assessed: 323 (95.2%)
Number of trees in dataset: **119,310**
Number of trees assessed: **114,679 (96.1%)**

Table 19: The proportion of Casey's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	67%	24%	5%	2%	78%	13%	7%	2%
Emissions limited (RCP4.5 2040)	51%	32%	11%	5%	55%	21%	13%	10%
Business as usual (RCP8.5 2070)	31%	37%	8%	15%	34%	19%	26%	21%

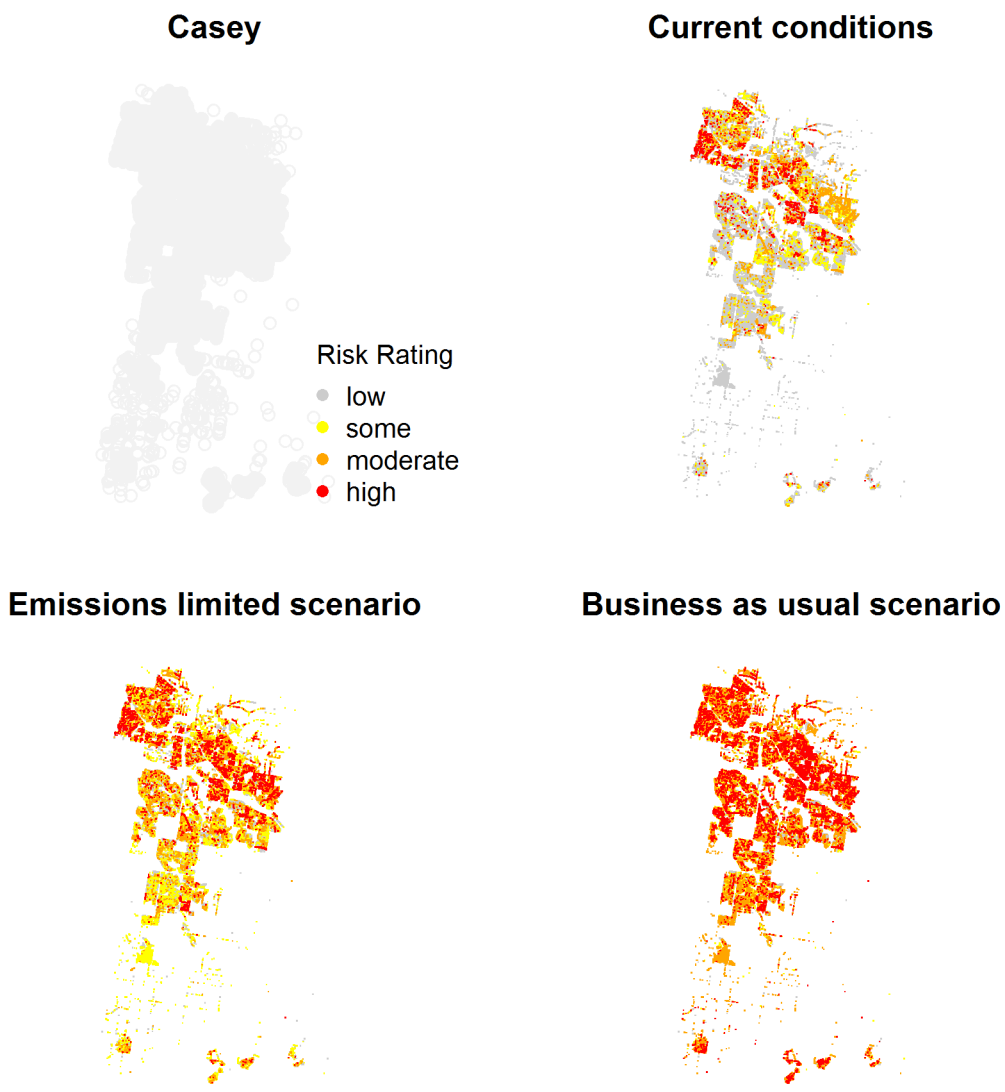

Figure 13: Risk to individual trees within Casey's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 20: Temperature risk of the most common species in Casey.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Eucalyptus spp.*	8.99%	10313	green	yellow	orange
2	*Callistemon spp.*	6.80%	7793	green	green	green
3	*Ulmus parvifolia*	6.28%	7204	green	green	green
4	*Eucalyptus leucoxylon*	4.60%	5273	green	green	yellow
5	*Pyrus calleryana*	4.45%	5108	green	green	green
6	*Tristaniopsis laurina*	4.31%	4940	green	green	yellow
7	*Pyrus ussuriensis*	3.61%	4139	green	yellow	orange
8	*Eucalyptus scoparia*	2.87%	3290	green	yellow	red
9	*Eucalyptus mannifera*	1.95%	2239	green	yellow	red
10	*Prunus nigra*	1.87%	2144	red	red	red
11	*Melaleuca linariifolia*	1.86%	2138	green	green	yellow
12	*Callistemon salignus*	1.86%	2132	green	green	green
13	*Unknown*		2120			
14	*Melia azedarach*	1.77%	2035	green	green	green
15	*Prunus spp.*	1.71%	1962	orange	orange	orange
16	*Corymbia ficifolia*	1.66%	1899	green	green	yellow
17	*Angophora costata*	1.58%	1807	green	green	yellow
18	*Lophostemon confertus*	1.38%	1588	green	green	green
19	*Quercus robur*	1.38%	1578	yellow	orange	red
20	*Fraxinus angustifolia*	1.26%	1443	green	yellow	orange
21	*Quercus palustris*	1.19%	1360	yellow	orange	orange
22	*Erythrophleum africanum*	1.14%	1313	green	green	green
23	*Agonis flexuosa*	1.09%	1255	green	green	yellow
24	*Eucalyptus pauciflora*	1.06%	1218	green	yellow	red
25	*Platanus acerifolia*	1.04%	1195	green	yellow	orange
26	*Corymbia maculata*	1.04%	1192	green	green	yellow
27	*Robinia pseudoacacia*	1.03%	1179	yellow	orange	orange
28	*Fraxinus excelsior*	1.02%	1166	orange	red	red
29	*Fraxinus griffithii*	0.98%	1126	green	green	green
30	*Melaleuca styphelioides*	0.97%	1114	green	green	green
31	*Pittosporum undulatum*	0.91%	1039	green	green	yellow
32	*Acer spp.*	0.89%	1016	yellow	orange	orange
33	*Callistemon pallidus*	0.83%	957	green	green	green
34	*Platanus orientalis*	0.82%	936	green	green	green
35	*Betula pendula*	0.82%	936	orange	orange	red
36	*Melaleuca armillaris*	0.75%	856	green	green	yellow
37	*Hakea salicifolia*	0.71%	813	green	green	yellow
38	*Callistemon citrinus*	0.66%	760	green	green	green
39	*Eucalyptus pulchella*	0.66%	760	yellow	red	red
40	*Eucalyptus nicholii*	0.62%	715	green	yellow	yellow
41	*Eucalyptus sideroxylon*	0.61%	705	green	green	green
42	*Lagerstroemia indica*	0.60%	687	green	green	green
43	*Allocasuarina littoralis*	0.51%	590	green	green	yellow
44	*Callistemon viminalis*	0.51%	590	green	green	green
45	*Prunus serrulata*	0.50%	575	yellow	yellow	yellow
46	*Cupressus macrocarpa*	0.45%	518	green	green	yellow
47	*Fraxinus spp.*	0.45%	518	yellow	orange	orange
48	*Pittosporum spp.*	0.44%	506	green	yellow	orange
49	*Leptospermum petersonii*	0.42%	484	green	green	green
50	*Eucalyptus cladocalyx*	0.41%	466	green	green	yellow

City of Darwin

Number of species in dataset: 46
Number of species assessed: 41 (89.1%)
Number of trees in dataset: **1,109**
Number of trees assessed: **947 (85.4%)**

*Table 21: The proportion of Darwin's urban forest at risk in future temperatures. * Note these very high figures are likely to reflect limitations in the data used – there is little information available on trees in very hot climates.*

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	24%	34%	14%	14%	2%	29%	29%	39%
Emissions limited (RCP4.5 2040)	0%	0%	1%	84%	0%	0%	2%	98%
Business as usual (RCP8.5 2070)	0%	0%	0%	85%	0%	0%	0%	100%

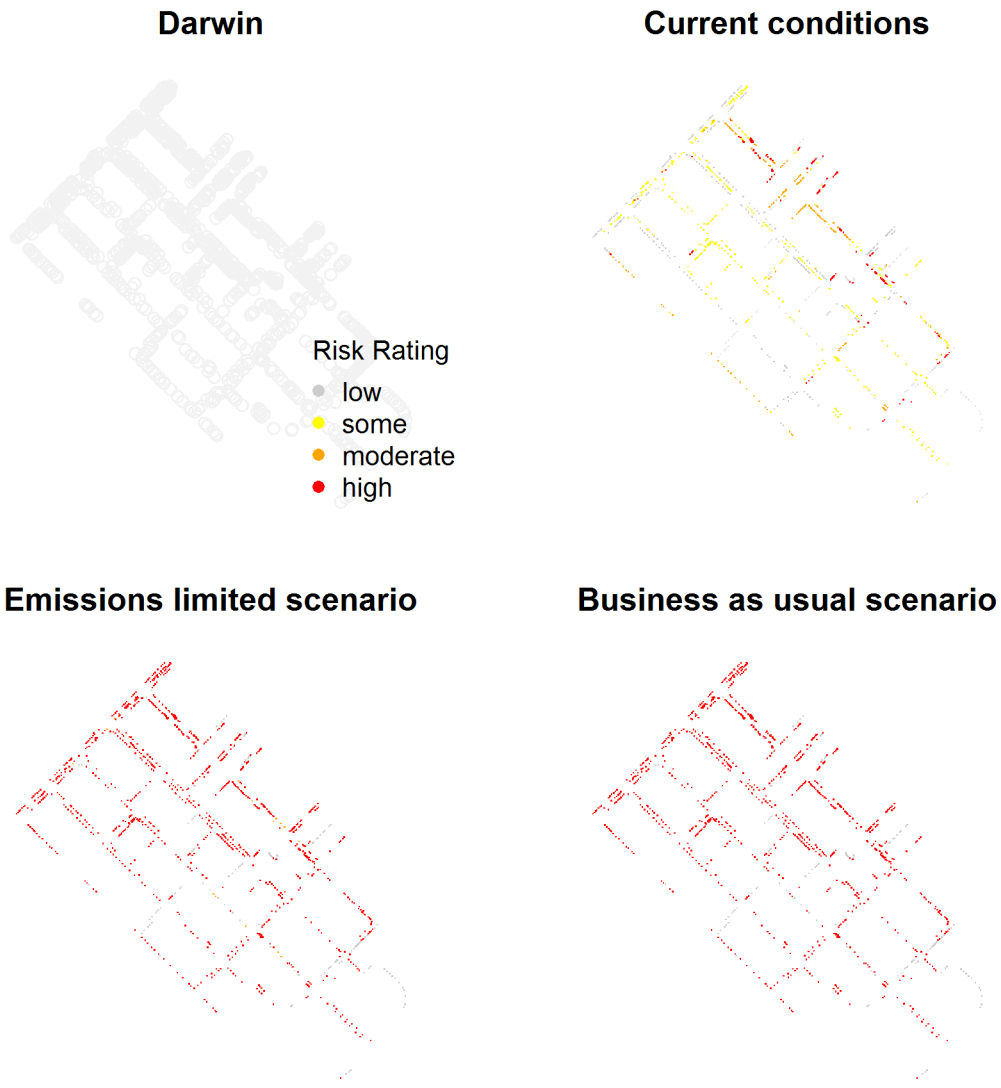

Figure 14: Risk to individual trees within Darwin's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

*Table 22: Temperature risk of the most common species in Darwin. * Note these very high figures are likely to reflect limitations in the data used – there is little information available on trees in very hot climates*

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Mimusops elengi*	28.30%	268	green	red	red
2	*Peltophorum pterocarpum*	23.55%	223	yellow	red	red
3	*Pterocarpus indicus*	11.30%	107	orange	red	red
4	*Unknown*		95			
5	*Archontophoenix spp.*		59			
6	*Dypsis lutescens*	5.81%	55	red	red	red
7	*Tabebuia rosea*	3.70%	35	yellow	red	red
8	*Roystonea regia*	3.59%	34	red	red	red
9	*Syzygium armstrongii*	2.43%	23	yellow	red	red
10	*Cocos nucifera*	2.11%	20	yellow	red	red
11	*Polyalthia longifolia*	1.80%	17	yellow	red	red
12	*Khaya senegalensis*	1.58%	15	yellow	red	red
13	*Albizia saman*	1.58%	15	red	red	red
14	*Livistona rigida*	1.58%	15	yellow	orange	red
15	*Dypsis spp.*	1.58%	15	yellow	red	red
16	*Livistona inermis*	1.27%	12	orange	red	red
17	*Staphylea pinnata*	1.27%	12	red	red	red
18	*Syzygium cumini*	1.16%	11	orange	red	red
19	*Ficus microcarpa*	1.06%	10	red	red	red
20	*Alstonia actinophylla*	0.84%	8	yellow	red	red
21	*Leptospermum madidum*	0.63%	6	red	red	red
22	*Dypsis madagascariensis*	0.63%	6	orange	red	red
23	*Plumeria obtusa*	0.63%	6	red	red	red
24	*Ficus virens*	0.42%	4	orange	red	red
25	*Phoenix spp.*		4			
26	*Acacia auriculiformis*	0.32%	3	orange	red	red
27	*Mangifera indica*	0.32%	3	orange	red	red
28	*Melaleuca leucadendra*	0.32%	3	orange	red	red
29	*Wodyetia bifurcata*	0.32%	3	red	red	red
30	*Corymbia ptychocarpa*	0.21%	2	red	red	red
31	*Plumeria rubra*	0.21%	2	orange	red	red
32	*Bismarckia nobilis*	0.21%	2			
33	*Cycas spp.*		2			
34	*Grevillea spp.*		2	red	red	red
35	*Ficus scobina*	0.11%	1	orange	red	red
36	*Livistona humilis*	0.11%	1	red	red	red
37	*Nauclea orientalis*	0.11%	1	red	red	red
38	*Delonix regia*	0.11%	1	orange	red	red
39	*Tamarindus indica*	0.11%	1	red	red	red
40	*Albizia lebbeck*	0.11%	1	yellow	red	red
41	*Spathodea campanulata*	0.11%	1	yellow	red	red
42	*Callistemon viminalis*	0.11%	1	yellow	red	red
43	*Citharexylum spinosum*	0.11%	1	red	red	red
44	*Ficus benjamina*	0.11%	1	red	red	red
45	*Schefflera actinophylla*	0.11%	1	red	red	red
46	*Tabebuia aurea*	0.11%	1	orange	red	red

City of Fremantle

Number of species in dataset: 186
Number of species assessed: 180 (96.8%)
Number of trees in dataset: **9,971**
Number of trees assessed: **9,934 (99.6%)**

Table 23: The proportion of Fremantle's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	26%	15%	20%	39%	35%	15%	18%	32%
Emissions limited (RCP4.5 2040)	20%	7%	23%	50%	28%	9%	17%	46%
Business as usual (RCP8.5 2070)	15%	11%	12%	61%	22%	12%	12%	55%

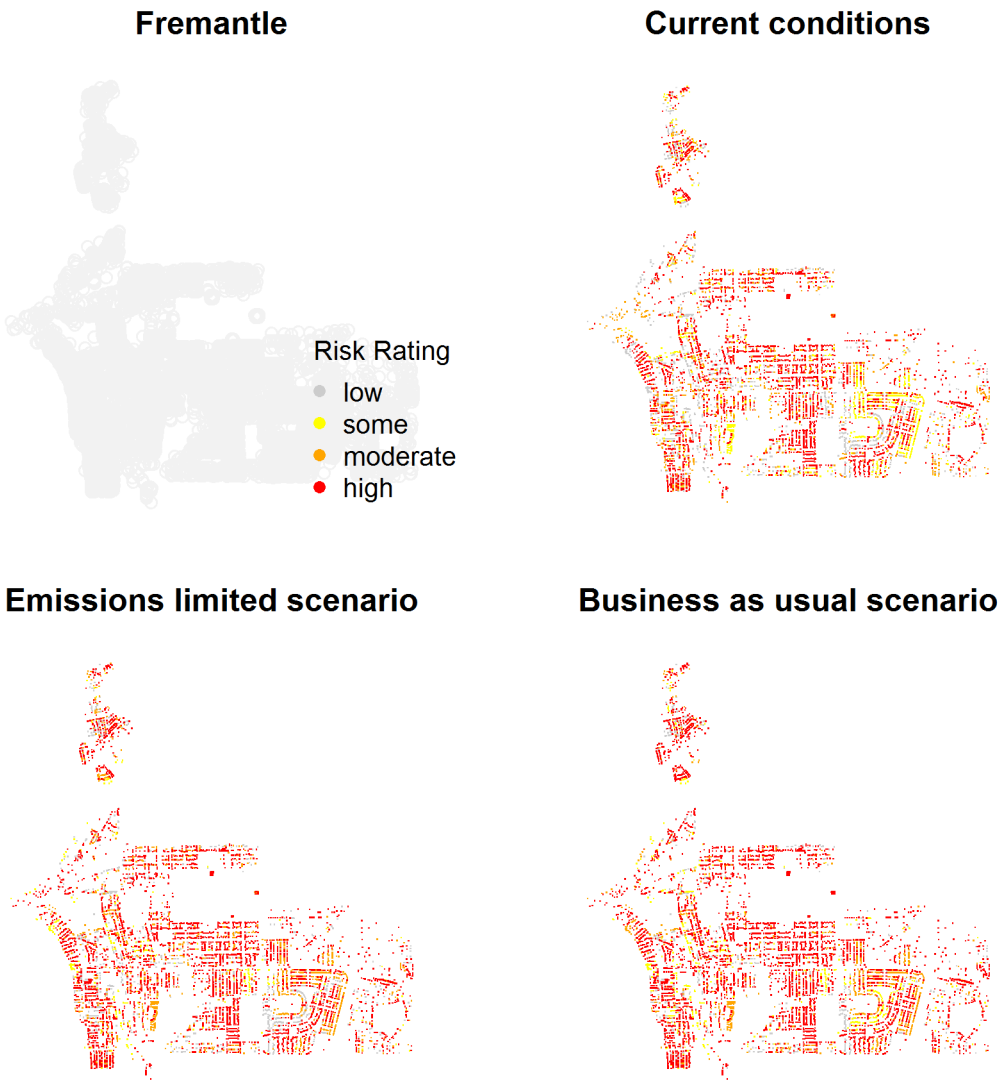

Figure 15: Risk to individual trees within Fremantle's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 24: Temperature risk of the most common species in Fremantle.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Agonis flexuosa*	17.83%	1771	red	red	red
2	*Lophostemon confertus*	5.36%	532	yellow	orange	orange
3	*Eucalyptus leucoxylon*	5.15%	512	orange	orange	red
4	*Corymbia ficifolia*	4.80%	477	orange	red	red
5	*Olea europaea*	4.69%	466	yellow	orange	orange
6	*Callistemon spp.*	4.30%	427	green	green	green
7	*Callistemon viminalis*	3.71%	369	green	green	green
8	*Araucaria heterophylla*	3.42%	340	green	yellow	yellow
9	*Jacaranda mimosifolia*	3.25%	323	green	green	yellow
10	*Eucalyptus torquata*	3.19%	317	red	red	red
11	*Eucalyptus gomphocephala*	2.89%	287	red	red	red
12	*Platanus acerifolia*	2.18%	217	orange	red	red
13	*Eucalyptus botryoides*	2.12%	211	red	red	red
14	*Eucalyptus spathulata*	2.02%	201	red	red	red
15	*Corymbia calophylla*	1.92%	191	red	red	red
16	*Eucalyptus platypus*	1.66%	165	orange	red	red
17	*Melaleuca quinquenervia*	1.53%	152	green	green	yellow
18	*Eucalyptus erythrocorys*	1.40%	139	green	orange	red
19	*Erythrina variegata*	1.37%	136	green	green	green
20	*Sapium sebiferum*	1.27%	126	green	green	green
21	*Eucalyptus conferruminata*	1.25%	124	red	red	red
22	*Eucalyptus cladocalyx*	1.24%	123	red	red	red
23	*Eucalyptus sideroxylon*	1.14%	113	orange	orange	red
24	*Eucalyptus spp.*	1.08%	107	orange	red	red
25	*Acacia saligna*	0.87%	86	yellow	orange	red
26	*Eucalyptus camaldulensis*	0.86%	85	green	yellow	yellow
27	*Ulmus parvifolia*	0.82%	81	yellow	orange	orange
28	*Eucalyptus marginata*	0.80%	79	red	red	red
29	*Ficus microcarpa*	0.70%	70	green	green	green
30	*Eucalyptus caesia*	0.64%	64	orange	red	red
31	*Tipuana tipu*	0.54%	54	green	yellow	yellow
32	*Acacia spp.*	0.47%	47	yellow	orange	red
33	*Corymbia citriodora*	0.43%	43	green	green	green
34	*Corymbia maculata*	0.43%	43	orange	orange	red
35	*Callitris preissii*	0.40%	40	red	red	red
36	*Melia azedarach*	0.39%	39	green	green	green
37	*Casuarina cunninghamiana*	0.39%	39	green	yellow	yellow
38	*Eucalyptus foecunda*	0.39%	39	orange	red	red
39	*Eucalyptus robusta*	0.38%	38	green	green	green
40	*Schinus terebinthifolia*	0.38%	38	green	green	green
41	*Casuarina spp.*	0.38%	38	green	yellow	yellow
42	*Melaleuca nesophila*	0.37%	37	orange	orange	red
43	*Eucalyptus lehmannii*	0.36%	36	red	red	red
44	*Hymenosporum flavum*	0.35%	35	yellow	orange	red
45	*Citrus limon*	0.33%	33	green	green	green
46	*Phoenix canariensis*	0.33%	33	green	green	yellow
47	*Casuarina equisetifolia*	0.32%	32	green	green	green
48	*Eucalyptus macrandra*	0.32%	32	orange	red	red
49	*Robinia pseudoacacia*	0.32%	32	red	red	red
50	*Eucalyptus carnei*	0.30%	30	green	yellow	orange

City of Greater Geelong

Number of species in dataset: 232
Number of species assessed: 219 (94.4%)
Number of trees in dataset: **146,678**
Number of trees assessed: **63,142 (43.0%)**

Table 25: The proportion of Geelong's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	86%	5%	1%	0%	79%	13%	7%	1%
Emissions limited (RCP4.5 2040)	78%	9%	5%	1%	58%	20%	14%	9%
Business as usual (RCP8.5 2070)	62%	15%	4%	4%	42%	16%	25%	17%

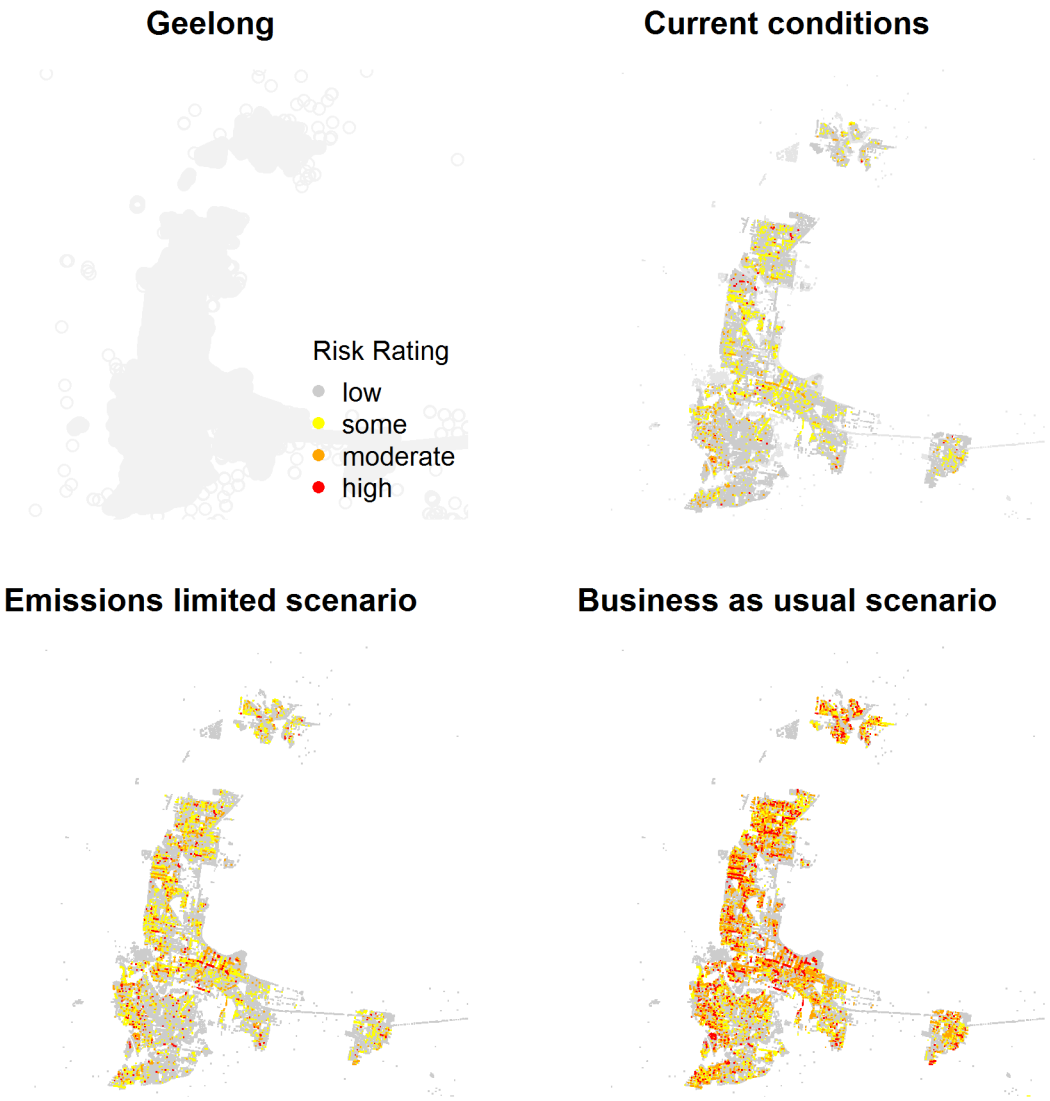

Figure 16: Risk to individual trees within Geelong's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 26: Temperature risk of the most common species in Geelong.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Callistemon citrinus*	9.80%	6190	green	green	green
2	*Lophostemon confertus*	7.84%	4951	green	green	green
3	*Callistemon spp.*	7.09%	4479	green	green	green
4	*Unknown*	6.45%	4073			
5	*Eucalyptus leucoxylon*	6.14%	3875	green	green	green
6	*Corymbia ficifolia*	5.66%	3571	green	green	yellow
7	*Melaleuca styphelioides*	3.27%	2064	green	green	green
8	*Pyrus calleryana*	3.16%	1993	green	green	green
9	*Callistemon viminalis*	3.01%	1898	green	green	green
10	*Melaleuca linariifolia*	2.62%	1652	green	green	green
11	*Prunus cerasifera*	2.23%	1408	yellow	yellow	orange
12	*Tristaniopsis laurina*	2.19%	1384	green	green	green
13	*Agonis flexuosa*	2.17%	1371	green	green	yellow
14	*Melaleuca armillaris*	1.89%	1193	green	green	green
15	*Fraxinus angustifolia*	1.81%	1146	green	yellow	orange
16	*Pittosporum undulatum*	1.65%	1045	green	green	yellow
17	*Eucalyptus cladocalyx*	1.57%	989	green	green	yellow
18	*Angophora costata*	1.54%	973	green	green	green
19	*Syzygium smithii*	1.51%	955	green	green	green
20	*Banksia integrifolia*	1.43%	905	green	green	green
21	*Callistemon salignus*	1.38%	869	green	green	green
22	*Prunus × blireiana*	1.23%	775	green	green	orange
23	*Acacia implexa*	0.99%	628	green	green	yellow
24	*Eucalyptus sideroxylon*	0.97%	612	green	green	green
25	*Eucalyptus scoparia*	0.90%	571	green	yellow	orange
26	*Corymbia citriodora*	0.88%	556	green	green	green
27	*Photinia × fraseri*	0.87%	552	green	green	green
28	*Lagunaria patersonia*	0.84%	533	green	green	green
29	*Corymbia maculata*	0.82%	517	green	green	green
30	*Melia azedarach*	0.80%	505	green	green	green
31	*Robinia pseudoacacia*	0.80%	502	yellow	yellow	orange
32	*Hakea laurina*	0.79%	501	green	green	orange
33	*Betula pendula*	0.65%	413	orange	orange	red
34	*Metrosideros spp.*	0.63%	396			
35	*Olea europaea*	0.58%	366	green	green	green
36	*Pittosporum eugenioides*	0.57%	362	green	yellow	orange
37	*Acacia melanoxylon*	0.56%	355	green	yellow	yellow
38	*Platanus acerifolia*	0.55%	347	green	yellow	orange
39	*Cupressus sempervirens*	0.54%	344	green	green	green
40	*Banksia marginata*	0.53%	336	green	orange	red
41	*Gleditsia triacanthos*	0.52%	330	green	green	yellow
42	*Fraxinus ornus*	0.51%	322	yellow	orange	red
43	*Cinnamomum camphora*	0.48%	303	green	green	green
44	*Lagerstroemia spp.*	0.48%	300			
45	*Nerium oleander*	0.47%	298	green	green	green
46	*Eucalyptus nicholii*	0.46%	293	green	yellow	yellow
47	*Leptospermum laevigatum*	0.42%	267	green	green	yellow
48	*Quercus palustris*	0.42%	267	yellow	orange	orange
49	*Schinus molle*	0.41%	257	green	green	green
50	*Allocasuarina verticillata*	0.39%	248	green	green	green

City of Launceston

Number of species in dataset: 359
Number of species assessed: 349 (97.2%)
Number of trees in dataset: **30,369**
Number of trees assessed: **27,725 (91.3%)**

Table 27: The proportion of Launceston's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	78%	18%	2%	0%	83%	11%	3%	3%
Emissions limited (RCP4.5 2040)	63%	29%	5%	1%	68%	16%	10%	6%
Business as usual (RCP8.5 2070)	47%	30%	4%	7%	52%	18%	13%	16%

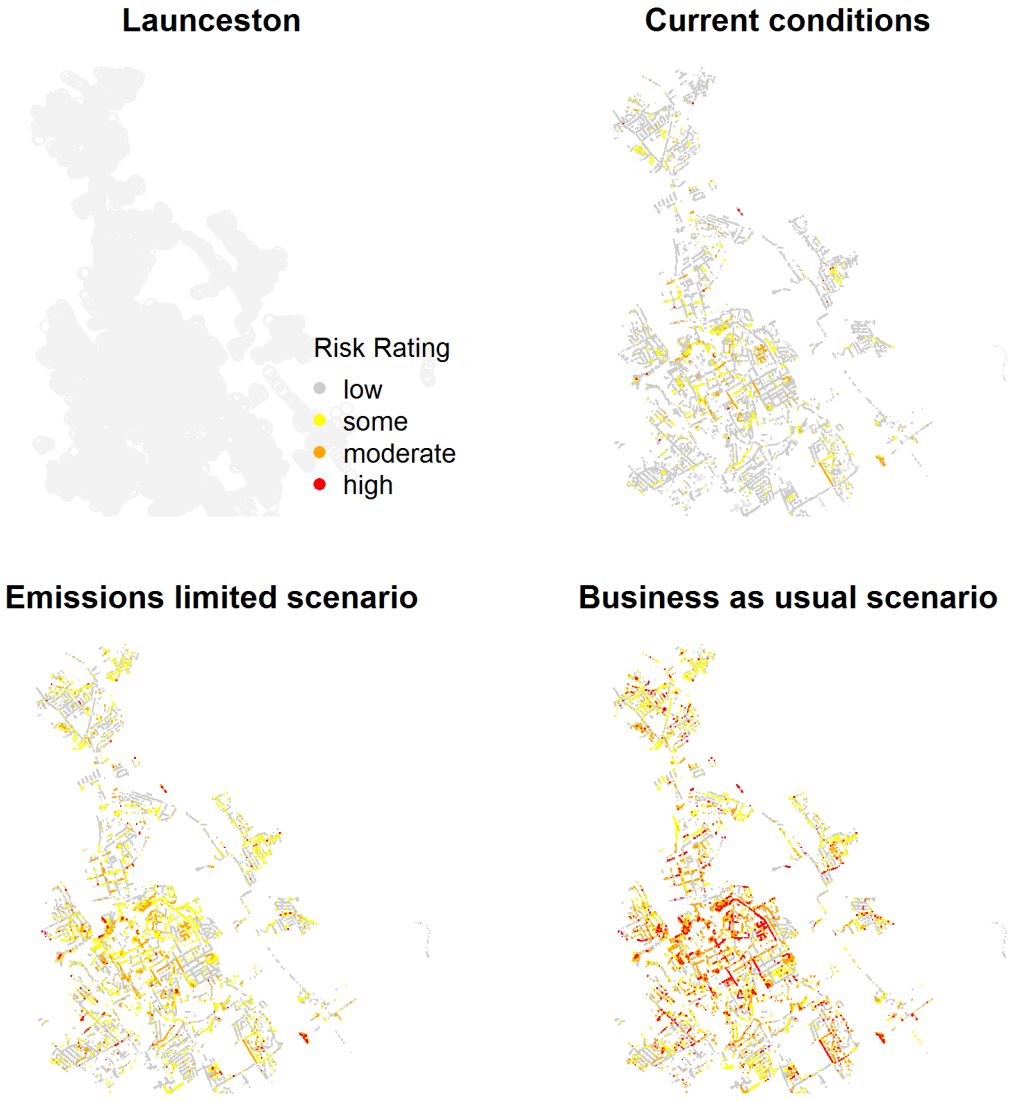

Figure 17: Risk to individual trees within Launceston's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 28: Temperature risk of the most common species in Launceston.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Eucalyptus spp.*	7.36%	2041	green	yellow	yellow
2	*Prunus × blireiana*	5.28%	1465	green	green	green
3	*Melaleuca linariifolia*	4.23%	1172	green	green	green
4	*Photinia × fraseri*	3.71%	1029	green	green	green
5	*Betula pendula*	3.43%	951	yellow	yellow	orange
6	*Acacia melanoxylon*	3.42%	949	green	green	green
7	*Ulmus × hollandica*	2.95%	818	green	yellow	orange
8	*Prunus cerasifera*	2.80%	776	green	green	yellow
9	*Callistemon salignus*	2.42%	670	green	green	green
10	*Prunus serrulata*	2.16%	598	green	green	yellow
11	*Acacia dealbata*	2.05%	567	green	green	green
12	*Prunus spp.*	1.99%	552	green	green	yellow
13	*Callistemon spp.*	1.71%	474	green	green	green
14	*Cotoneaster spp.*	1.60%	444	green	green	green
15	*Ulmus glabra*	1.46%	406	green	yellow	orange
16	*Pittosporum eugenioides*	1.41%	392	green	green	yellow
17	*Eucalyptus viminalis*	1.38%	382	green	green	yellow
18	*Quercus robur*	1.30%	360	green	yellow	orange
19	*Fraxinus excelsior*	1.29%	358	yellow	orange	orange
20	*Acacia spp.*	1.22%	339	green	green	green
21	*Unknown*		328			
22	*Melaleuca styphelioides*	1.14%	316	green	green	green
23	*Malus spp.*	1.06%	294	green	yellow	red
24	*Callistemon viminalis*	1.02%	284	green	green	green
25	*Pinus radiata*	1.02%	284	green	green	yellow
26	*Sorbus aucuparia*	1.02%	284	orange	orange	red
27	*Allocasuarina verticillata*	0.97%	268	green	green	green
28	*Malus ioensis*	0.94%	262	green	yellow	red
29	*Tilia × europaea*	0.92%	254	orange	orange	red
30	*Fraxinus angustifolia*	0.89%	248	green	green	green
31	*Leptospermum spp.*	0.88%	245	green	green	green
32	*Liquidambar styraciflua*	0.85%	236	green	green	green
33	*Hibiscus syriacus*	0.83%	229	green	green	green
34	*Ulmus parvifolia*	0.78%	215	green	green	green
35	*Eucalyptus globulus*	0.76%	212	green	green	green
36	*Acacia baileyana*	0.71%	197	green	green	green
37	*Ulmus minor*	0.71%	197	green	yellow	orange
38	*Allocasuarina spp.*	0.70%	195	green	green	green
39	*Schinus molle*	0.64%	177	green	green	green
40	*Acacia mearnsii*	0.61%	169	green	green	green
41	*Crataegus monogyna*	0.57%	159	yellow	yellow	red
42	*Platanus acerifolia*	0.57%	157	green	green	green
43	*Populus nigra*	0.55%	153	green	green	yellow
44	*Rhododendron spp.*		152			
45	*Quercus palustris*	0.52%	143	green	green	yellow
46	*Acacia pravissima*	0.51%	141	green	green	yellow
47	*Allocasuarina littoralis*	0.50%	140	green	green	green
48	*Laburnum watereri*	0.48%	132	green	yellow	orange
49	*Corymbia ficifolia*	0.47%	129	green	green	green
50	*Viburnum tinus*	0.47%	129	green	green	green

City of Melbourne

Number of species in dataset: 420
Number of species assessed: 402 (95.7%)
Number of trees in dataset: 67,462
Number of trees assessed: 65,976 (97.8%)

Table 29: The proportion of the City of Melbourne's urban forest at risk in future temperatures.

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	63%	19%	9%	11%	61%	14%	13%	11%
Emissions limited (RCP4.5 2040)	38%	18%	24%	18%	38%	15%	21%	25%
Business as usual (RCP8.5 2070)	25%	10%	13%	32%	23%	14%	21%	43%

Figure 18: Risk to individual trees within the City of Melbourne's urban forest colour coded for temperature risk under current, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 30: Temperature risk of the most common species in the City of Melbourne.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Eucalyptus camaldulensis*	7918	11.7%	green	green	green
2	*Platanus acerifolia*	5392	8.0%	yellow	orange	orange
3	*Corymbia maculata*	3118	4.6%	green	yellow	orange
4	*Eucalyptus melliodora*	2814	4.2%	green	orange	red
5	*Allocasuarina verticillata*	2635	3.9%	green	green	orange
6	*Ulmus* spp.	2558	3.8%	orange	red	red
7	*Ulmus minor*	2098	3.1%	red	red	red
8	*Eucalyptus leucoxylon*	1912	2.8%	green	yellow	orange
9	*Corymbia citriodora*	1508	2.2%	green	green	green
10	Unknown	1431				
11	*Angophora costata*	1299	1.9%	green	yellow	red
12	*Acacia mearnsii*	1273	1.9%	yellow	red	red
13	*Acacia implexa*	1068	1.6%	green	orange	orange
14	*Acacia melanoxylon*	915	1.4%	yellow	orange	orange
15	*Lophostemon confertus*	907	1.3%	green	green	yellow
16	*Eucalyptus sideroxylon*	843	1.2%	green	green	orange
17	*Melia azedarach*	799	1.2%	green	green	green
18	*Quercus palustris*	736	1.1%	orange	orange	red
19	*Ficus macrophylla*	724	1.1%	green	green	green
20	*Casuarina cunninghamiana*	690	1.0%	green	green	green
21	*Acer × freemanii*	644	1.0%	red	red	red
22	*Zelkova serrata*	633	0.9%	green	yellow	yellow
23	*Schinus molle*	624	0.9%	green	green	yellow
24	*Acacia pycnantha*	601	0.9%	yellow	red	red
25	*Eucalyptus* spp.	591	0.9%	green	yellow	yellow
26	*Tristaniopsis laurina*	587	0.9%	green	yellow	orange
27	*Ulmus × hollandica*	584	0.9%	red	red	red
28	*Eucalyptus cladocalyx*	537	0.8%	green	yellow	red
29	*Platanus orientalis*	537	0.8%	green	green	yellow
30	*Eucalyptus polyanthemos*	530	0.8%	green	yellow	red
31	*Ficus microcarpa*	494	0.7%	green	green	green
32	*Acacia retinodes*	484	0.7%	yellow	orange	red
33	*Casuarina obesa*	475	0.7%	green	green	green
34	*Ulmus parvifolia*	470	0.7%	green	green	yellow
35	*Celtis australis*	429	0.6%	green	orange	red
36	*Phoenix canariensis*	407	0.6%	green	green	green
37	*Syzygium floribundum*	404	0.6%	orange	red	red
38	*Acacia dealbata*	404	0.6%	green	green	green
39	*Callistemon salignus*	398	0.6%	green	green	yellow
40	*Agathis robusta*	391	0.6%	green	green	green
41	*Banksia integrifolia*	359	0.5%	green	green	orange
42	*Pyrus calleryana*	359	0.5%	green	green	yellow
43	*Eucalyptus viminalis*	357	0.5%	orange	red	red
44	*Ginkgo biloba*	356	0.5%	yellow	orange	orange
45	*Quercus robur*	353	0.5%	orange	red	red
46	*Brachychiton acerifolius*	331	0.5%	green	green	orange
47	*Melaleuca linariifolia*	330	0.5%	green	yellow	orange
48	*Corymbia ficifolia*	325	0.5%	green	orange	orange
49	*Callistemon pallidus*	308	0.5%	green	green	yellow
50	*Melaleuca styphelioides*	304	0.5%	green	green	orange

City of Perth

Number of species in dataset: 233
Number of species assessed: 228 (97.9%)
Number of trees in dataset: **12,096**
Number of trees assessed: **12,087 (99.9%)**

Table 31: The proportion of Perth's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	32%	25%	30%	13%	42%	15%	17%	25%
Emissions limited (RCP4.5 2040)	26%	10%	30%	33%	32%	13%	18%	38%
Business as usual (RCP8.5 2070)	8%	21%	9%	55%	23%	11%	18%	47%

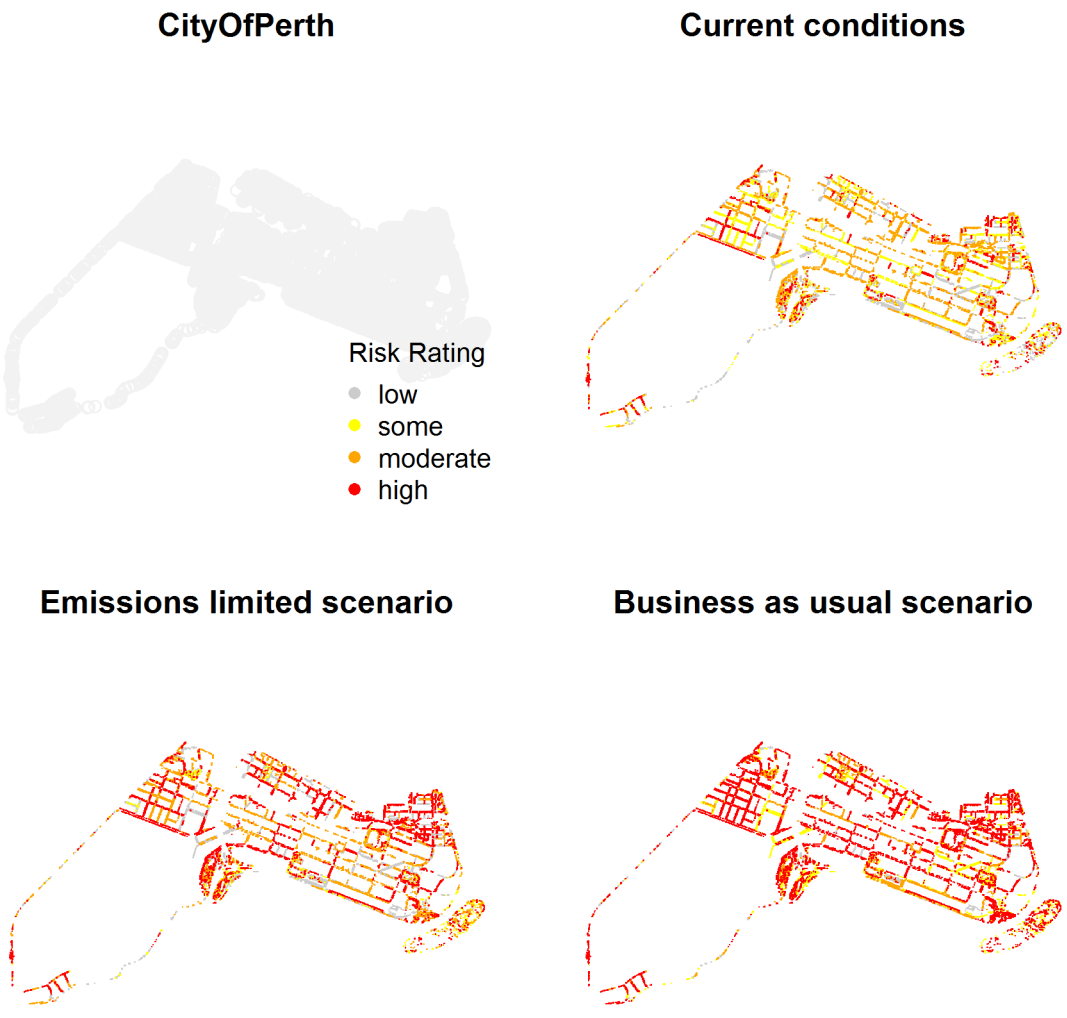

Figure 19: Risk to individual trees within Perth's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 32: Temperature risk of the most common species in Perth.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Platanus acerifolia*	13.83%	1672	orange	red	red
2	*Corymbia maculata*	6.27%	758	orange	orange	red
3	*Jacaranda mimosifolia*	6.26%	757	green	green	yellow
4	*Lophostemon confertus*	5.46%	660	yellow	orange	red
5	*Eucalyptus rudis*	4.75%	574	yellow	orange	red
6	*Phoenix canariensis*	3.55%	429	green	green	orange
7	*Agonis flexuosa*	3.23%	390	red	red	red
8	*Melaleuca quinquenervia*	3.14%	380	green	green	yellow
9	*Casuarina cunninghamiana*	2.38%	288	yellow	yellow	yellow
10	*Ficus microcarpa*	2.13%	258	green	yellow	yellow
11	*Eucalyptus camaldulensis*	2.13%	258	green	green	green
12	*Erythrina × sykesii*	1.92%	232	orange	red	red
13	*Casuarina obesa*	1.89%	228	green	orange	red
14	*Liquidambar styraciflua*	1.84%	222	yellow	orange	orange
15	*Olea europaea*	1.83%	221	yellow	orange	orange
16	*Washingtonia robusta*	1.81%	219	green	green	yellow
17	*Corymbia ficifolia*	1.69%	204	orange	red	red
18	*Brachychiton acerifolius*	1.52%	184	orange	orange	red
19	*Platanus orientalis*	1.45%	175	yellow	red	red
20	*Lagunaria patersonia*	1.43%	173	orange	orange	orange
21	*Angophora costata*	1.23%	149	red	red	red
22	*Callistemon viminalis*	1.14%	138	green	green	green
23	*Callistemon spp.*	1.14%	138	green	green	green
24	*Ulmus parvifolia*	1.06%	128	yellow	orange	orange
25	*Washingtonia filifera*	0.94%	114	green	green	yellow
26	*Corymbia calophylla*	0.92%	111	red	red	red
27	*Brachychiton populneus*	0.88%	106	yellow	yellow	orange
28	*Corymbia citriodora*	0.81%	98	green	green	green
29	*Melaleuca rhaphiophylla*	0.77%	93	yellow	red	red
30	*Fraxinus angustifolia*	0.75%	91	red	red	red
31	*Eucalyptus gomphocephala*	0.71%	86	red	red	red
32	*Citharexylum spinosum*	0.66%	80	green	green	green
33	*Ficus macrophylla*	0.65%	78	yellow	yellow	orange
34	*Pyrus ussuriensis**	0.65%	78	red	red	red
35	*Araucaria heterophylla*	0.61%	74	green	yellow	orange
36	*Eucalyptus sideroxylon*	0.61%	74	orange	orange	red
37	*Cinnamomum camphora*	0.60%	72	green	green	orange
38	*Populus nigra*	0.49%	59	orange	orange	orange
39	*Eucalyptus leucoxylon*	0.42%	51	orange	orange	red
40	*Melaleuca lanceolata*	0.41%	50	red	red	red
41	*Robinia ambigua*	0.41%	50	red	red	red
42	*Tipuana tipu*	0.40%	48	green	yellow	yellow
43	*Sapium sebiferum*	0.38%	46	green	green	yellow
44	*Zelkova serrata*	0.38%	46	yellow	orange	orange
45	*Gleditsia triacanthos*	0.37%	45	orange	orange	red
46	*Magnolia grandiflora*	0.36%	44	yellow	orange	orange
47	*Eucalyptus victrix*	0.36%	43	green	green	green
48	*Eucalyptus botryoides*	0.35%	42	red	red	red
49	*Ficus obliqua*	0.34%	41	green	green	green
50	*Eucalyptus utilis*	0.31%	38	red	red	red

* likely to be *Pyrus calleryana*

City of Prospect, Adelaide

Number of species in dataset: 50
Number of species assessed: 36 (72.0%)
Number of trees in dataset: **11,170**
Number of trees assessed: **8,217 (73.6%)**

Table 33: The proportion of the City of Prospect's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	44%	19%	21%	7%	47%	14%	22%	17%
Emissions limited (RCP4.5 2040)	24%	34%	6%	26%	28%	14%	19%	39%
Business as usual (RCP8.5 2070)	24%	2%	4%	28%	22%	8%	19%	50%

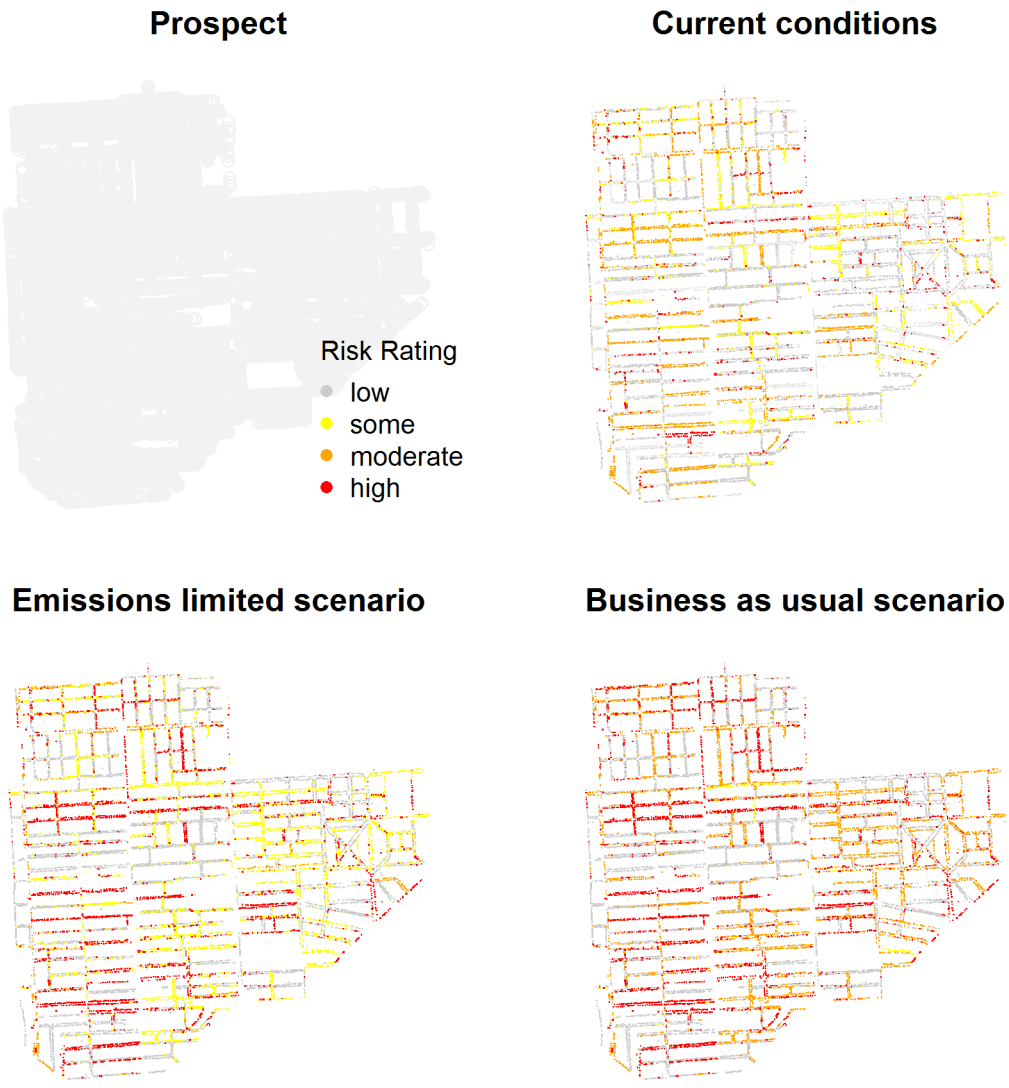

Figure 20: Risk to individual trees within Prospect Shire's urban forest colour coded for temperature risk under current climate, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 34: Temperature risk of the most common species in the City of Prospect

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Melia azedarach*	18.63%	1531	green	green	green
2	*Lophostemon confertus*	17.71%	1455	green	yellow	orange
3	*Koelreuteria paniculata*	17.55%	1442	yellow	yellow	orange
4	*Celtis occidentalis*	12.80%	1052	orange	red	red
5	*Callistemon spp.*		563			
6	*Pyrus ussuriensis**	5.91%	486	orange	red	red
7	*Eucalyptus spp.*	5.89%	484	red	red	red
8	*Jacaranda mimosifolia*	5.81%	477	green	green	green
9	*Platanus acerifolia*	2.76%	227	orange	orange	orange
10	*Melaleuca spp.*	1.86%	153			
11	*Acer negundo*	1.55%	127	orange	red	red
12	*Fraxinus ornus*	1.50%	123	red	red	red
13	*Lagerstroemia indica*	1.46%	120	green	green	green
14	*Gleditsia triacanthos*	1.24%	102	yellow	orange	orange
15	*Ulmus parvifolia*	1.20%	99	green	yellow	yellow
16	*Cercis siliquastrum*	1.02%	84	yellow	orange	red
17	*Pyrus calleryana*	0.89%	73	green	yellow	orange
18	*Acacia pendula*	0.86%	71	green	orange	red
19	*Prunus spp.*		56			
20	*Allocasuarina spp.*		46			
21	*Acer buergerianum*	0.55%	45	orange	red	red
22	*Celtis australis*	0.49%	40	yellow	red	red
23	*Acacia spp.*	0.44%	36	green	orange	red
24	*Photinia × fraseri*	0.26%	21	green	green	yellow
25	*Ulmus minor*	0.24%	20	red	red	red
26	*Nerium oleander*	0.22%	18	green	green	green
27	*Sapium sebiferum*	0.22%	18	green	green	green
28	*Ulmus spp.*	0.21%	17	yellow	orange	orange
29	*Cupressus spp.*		16			
30	*Arecaceae spp.*		11			
31	*Betula pendula*	0.11%	9	red	red	red
32	*Pistacia chinensis*	0.09%	7	green	green	yellow
33	*Schinus molle*	0.09%	7	green	yellow	orange
34	*Corymbia citriodora*	0.07%	6	green	green	green
35	*Cinnamomum camphora*	0.06%	5	green	green	green
36	*Grevillea robusta*	0.06%	5	green	green	green
37	*Ficus spp.*		5			
38	*Syzygium smithii*	0.04%	3	green	orange	red
39	*Acer spp.*	0.04%	3	orange	red	red
40	*Cotoneaster spp.*		3			
41	*Banksia spp.*		2			
42	*Hakea spp.*		2			
43	*Robinia pseudoacacia*	0.01%	1	orange	red	red
44	*Quercus palustris*	0.01%	1	orange	red	red
45	*Eucalyptus viminalis*	0.01%	1	red	red	red
46	*Betula × sargentii*	0.01%	1	red	red	red
47	*Crataegus spp.*		1			
48	*Leptospermum spp.*		1			
49	*Pittosporum spp.*		1			
50	*Populus spp.*		1			

* likely also to be *Pyrus calleryana*

City of Sydney

Number of species in dataset: 311
Number of species assessed: 298 (95.8%)
Number of trees in dataset: **38,987**
Number of trees assessed: **38,805 (99.5%)**

Table 35: The proportion of City of Sydney's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	39%	21%	29%	12%	45%	13%	19%	24%
Emissions limited (RCP4.5 2040)	32%	9%	39%	20%	32%	15%	17%	37%
Business as usual (RCP8.5 2070)	12%	22%	12%	50%	19%	12%	20%	49%

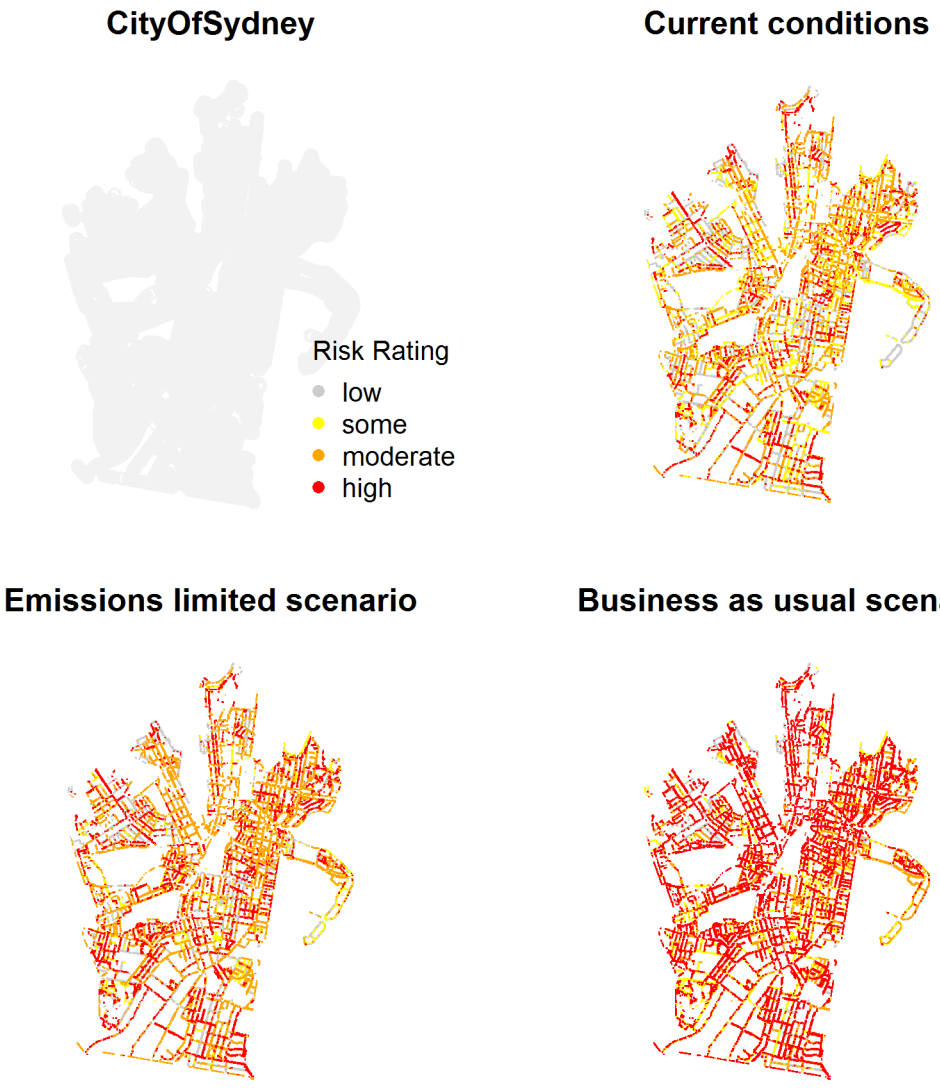

Figure 21: Risk to individual trees within the City of Sydney's urban forest colour coded for temperature risk under current climate, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 36: Temperature risk of the most common species in the City of Sydney.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Lophostemon confertus*	9.70%	3764	yellow	orange	red
2	*Platanus acerifolia*	9.47%	3674	orange	orange	red
3	*Melaleuca quinquenervia*	9.34%	3626	green	green	yellow
4	*Tristaniopsis laurina*	4.89%	1896	orange	orange	red
5	*Robinia pseudoacacia*	3.83%	1487	red	red	red
6	*Corymbia maculata*	3.58%	1389	orange	orange	red
7	*Jacaranda mimosifolia*	3.35%	1301	green	green	yellow
8	*Elaeocarpus reticulatus*	2.63%	1022	orange	red	red
9	*Cupaniopsis anacardioides*	2.44%	948	green	green	green
10	*Callistemon viminalis*	2.24%	869	green	green	green
11	*Ficus microcarpa*	1.87%	726	green	green	green
12	*Eucalyptus microcorys*	1.70%	658	orange	red	red
13	*Fraxinus griffithii*	1.52%	588	green	green	yellow
14	*Lagerstroemia indica*	1.47%	571	green	green	green
15	*Pistacia chinensis*	1.45%	563	green	yellow	orange
16	*Sapium sebiferum*	1.32%	511	green	green	yellow
17	*Livistona australis*	1.30%	506	green	green	yellow
18	*Liquidambar styraciflua*	1.30%	505	yellow	orange	orange
19	*Ficus rubiginosa*	1.25%	484	yellow	yellow	yellow
20	*Flindersia australis*	1.20%	467	green	yellow	orange
21	*Platanus orientalis*	1.17%	453	yellow	orange	red
22	*Angophora costata*	1.17%	453	red	red	red
23	*Celtis australis*	1.08%	419	red	red	red
24	*Populus simonii*	1.04%	403	red	red	red
25	*Casuarina glauca*	1.00%	389	yellow	red	red
26	*Corymbia citriodora*	0.97%	378	green	green	green
27	*Ulmus parvifolia*	0.97%	376	yellow	yellow	orange
28	*Eucalyptus sideroxylon*	0.92%	357	orange	orange	red
29	*Koelreuteria paniculata*	0.90%	348	yellow	orange	orange
30	*Fraxinus pennsylvanica*	0.88%	343	orange	orange	red
31	*Casuarina cunninghamiana*	0.86%	333	green	yellow	yellow
32	*Magnolia grandiflora*	0.76%	296	green	yellow	orange
33	*Eucalyptus botryoides*	0.65%	252	red	red	red
34	*Populus nigra*	0.63%	245	orange	orange	orange
35	*Eucalyptus spp.*	0.61%	238	orange	orange	red
36	*Syzygium floribundum*	0.55%	214	green	yellow	orange
37	*Eucalyptus saligna*	0.55%	214	yellow	orange	red
38	*Fraxinus angustifolia*	0.54%	210	red	red	red
39	*Olea europaea*	0.51%	197	yellow	orange	orange
40	*Ficus benjamina*	0.47%	183	green	green	green
41	*Populus deltoides*	0.46%	177	yellow	orange	orange
42	*Banksia integrifolia*	0.44%	170	yellow	orange	red
43	*Eucalyptus scoparia*	0.43%	166	red	red	red
44	*Washingtonia robusta*	0.41%	161	green	green	yellow
45	*Liriodendron tulipifera*	0.40%	157	orange	red	red
46	*Brachychiton acerifolius*	0.40%	154	orange	orange	red
47	*Celtis occidentalis*	0.36%	140	red	red	red
48	*Callistemon salignus*	0.36%	139	yellow	red	red
49	*Eucalyptus robusta*	0.35%	136	green	green	yellow
50	*Syzygium paniculatum*	0.35%	136	orange	red	red

City of Townsville

Number of species in dataset: 122
Number of species assessed: 110 (90.2%)
Number of trees in dataset: **20,076**
Number of trees assessed: **14,613 (72.8%)**

Table 37: The proportion of Townsville's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	41%	22%	15%	4%	42%	13%	15%	31%
Emissions limited (RCP4.5 2040)	38%	11%	19%	17%	34%	9%	15%	42%
Business as usual (RCP8.5 2070)	11%	17%	13%	29%	16%	12%	15%	57%

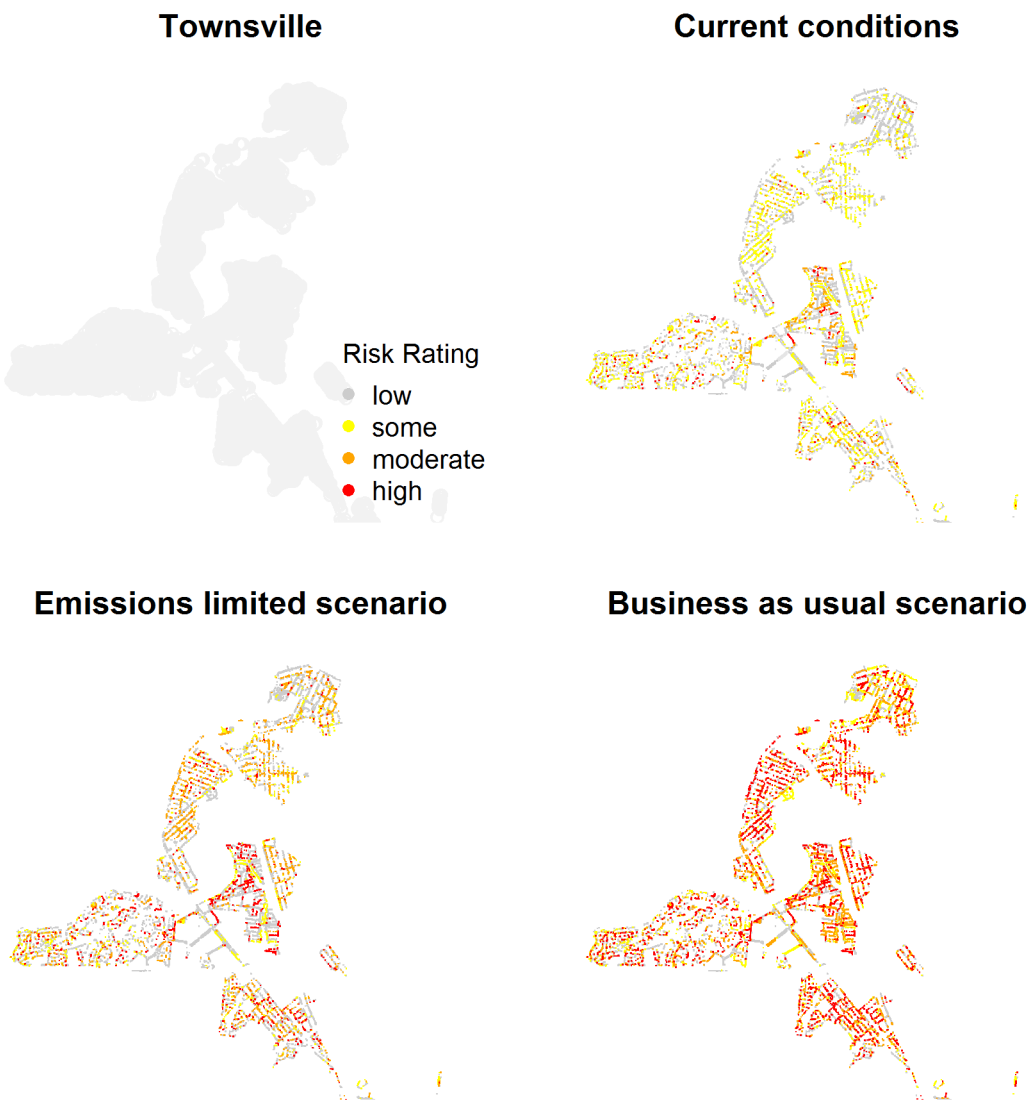

Figure 22: Risk to individual trees within Townsville's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 38: Temperature risk of the most common species in Townsville.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	Unknown		2655			
2	*Tabebuia pallida*	8.60%	1256	green	green	orange
3	*Syzygium spp.*	8.48%	1239	orange	red	red
4	*Arecaceae spp.*		1162			
5	*Xanthostemon chrysanthus*	6.97%	1018	yellow	orange	red
6	*Cupaniopsis anacardioides*	5.61%	820	green	green	yellow
7	*Callistemon viminalis*	5.56%	813	yellow	orange	red
8	*Melaleuca spp.*	5.47%	799	yellow	yellow	orange
9	*Eucalyptus spp.*	5.42%	792	yellow	yellow	yellow
10	*Handroanthus impetiginosus*	4.93%	720	green	green	orange
11	*Peltophorum pterocarpum*	4.44%	649	green	green	green
12	*Mimusops elengi*	4.40%	643	green	green	green
13	*Callistemon spp.*	3.78%	552	yellow	orange	red
14	*Ficus benjamina*	3.05%	446	green	green	yellow
15	*Delonix regia*	2.54%	371	green	green	yellow
16	*Plumeria obtusa*	2.48%	363	green	green	orange
17	*Syzygium floribundum*	2.11%	308	orange	red	red
18	*Tabebuia aurea*	2.05%	299	green	green	orange
19	*Leptospermum parviflorum*	1.88%	274	green	green	yellow
20	*Melaleuca bracteata*	1.70%	249	green	yellow	orange
21	*Fraxinus spp.*	1.31%	192	orange	red	red
22	*Cassia spp.*		187			
23	*Terminalia catappa*	1.20%	175	green	green	yellow
24	*Albizia lebbeck*	1.17%	171	green	green	green
25	*Khaya senegalensis*	1.17%	171	green	green	green
26	*Ficus* spp.	1.02%	149	green	green	yellow
27	*Fraxinus griffithii*	0.98%	143	orange	red	red
28	*Caryota mitis*	0.94%	138	green	green	green
29	*Evodiella muelleri*	0.91%	133	yellow	red	red
30	*Agathis robusta*	0.77%	112	orange	orange	red
31	*Mangifera indica*	0.71%	104	green	green	green
32	*Corymbia tessellaris*	0.67%	98	green	green	red
33	*Castanospermum australe*	0.62%	91	yellow	orange	red
34	*Albizia saman*	0.57%	84	green	green	green
35	*Casuarina* spp.		82			
36	*Melaleuca lanceolata*	0.53%	78	red	red	red
37	*Melaleuca leucadendra*	0.50%	73	green	green	yellow
38	*Brachychiton* spp.	0.49%	72	red	red	red
39	*Eucalyptus alba*	0.49%	71	green	green	green
40	*Callistemon citrinus*	0.45%	66	orange	red	red
41	*Ficus benghalensis*	0.38%	56	green	green	yellow
42	*Lophostemon confertus*	0.38%	55	red	red	red
43	*Acacia* spp.	0.36%	53	orange	orange	orange
44	*Lagerstroemia indica*	0.31%	46	yellow	orange	orange
45	*Grevillea hilliana*	0.31%	45	red	red	red
46	*Dypsis decaryi*	0.30%	44	red	red	red
47	*Grevillea* spp.	0.29%	43	red	red	red
48	*Tamarindus indica*	0.29%	43	green	green	green
49	*Caesalpinia ferrea*	0.27%	40	green	yellow	orange
50	*Corymbia gummifera*	0.27%	39	red	red	red

City of Whittlesea, Melbourne

Number of species in dataset: 319
Number of species assessed: 317 (99.4%)
Number of trees in dataset: **77,734**
Number of trees assessed: **77,424 (99.6%)**

Table 39: The proportion of Whittlesea's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	87%	12%	1%	0%	79%	13%	6%	3%
Emissions limited (RCP4.5 2040)	70%	23%	6%	1%	61%	16%	12%	11%
Business as usual (RCP8.5 2070)	42%	26%	10%	6%	36%	19%	25%	20%

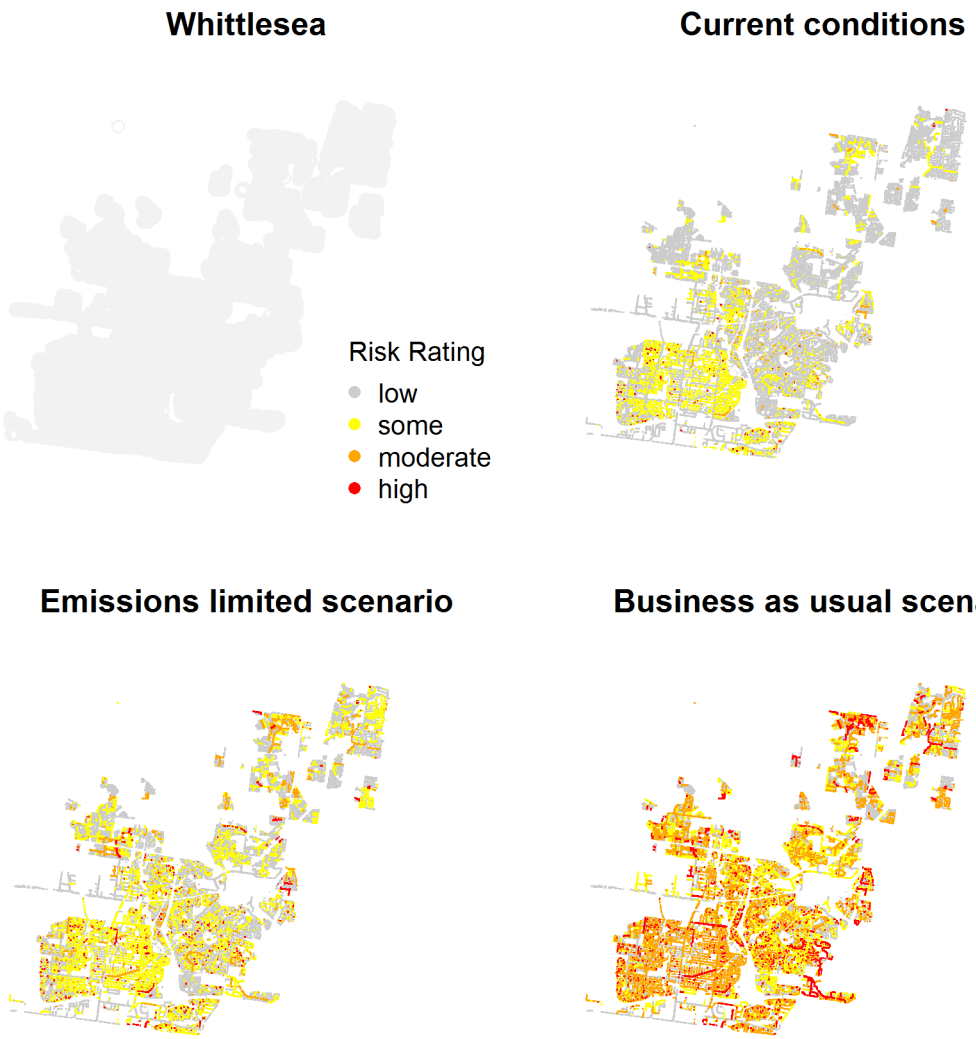

Figure 23: Risk to individual trees within Whittlesea's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 40: Temperature risk of the most common species in Whittlesea.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Eucalyptus scoparia*	5.90%	4570	green	yellow	orange
2	*Eucalyptus leucoxylon*	5.83%	4511	green	green	yellow
3	*Angophora costata*	4.92%	3807	green	green	yellow
4	*Prunus cerasifera*	4.57%	3540	yellow	yellow	orange
5	*Pyrus calleryana*	4.19%	3247	green	green	green
6	*Corymbia ficifolia*	3.86%	2988	green	green	yellow
7	*Corymbia maculata*	3.55%	2748	green	green	yellow
8	*Corymbia citriodora*	3.28%	2537	green	green	green
9	*Eucalyptus mannifera*	2.73%	2114	green	yellow	orange
10	*Melia azedarach*	2.50%	1933	green	green	green
11	*Eucalyptus sideroxylon*	2.44%	1888	green	green	green
12	*Olea europaea*	2.43%	1879	green	green	green
13	*Melaleuca styphelioides*	2.23%	1724	green	green	green
14	*Corymbia eximia*	2.12%	1642	green	green	orange
15	*Agonis flexuosa*	1.84%	1421	green	green	yellow
16	*Eucalyptus pulchella*	1.75%	1355	yellow	orange	red
17	*Pyrus ussuriensis*	1.67%	1292	green	yellow	orange
18	*Callistemon salignus*	1.64%	1267	green	green	green
19	*Melaleuca linariifolia*	1.64%	1266	green	green	yellow
20	*Eucalyptus polyanthemos*	1.33%	1030	green	green	yellow
21	*Lophostemon confertus*	1.31%	1012	green	green	green
22	*Ulmus parvifolia*	1.27%	983	green	green	green
23	*Callistemon viminalis*	1.14%	885	green	green	green
24	*Callistemon spp.*	1.10%	849	green	green	green
25	*Brachychiton acerifolius*	1.09%	847	green	green	green
26	*Acacia implexa*	1.02%	792	green	green	orange
27	*Platanus acerifolia*	1.00%	776	green	yellow	orange
28	*Eucalyptus melliodora*	0.99%	769	green	green	orange
29	*Eucalyptus spp.*	0.98%	756	green	yellow	orange
30	*Acer rubrum*	0.96%	743	yellow	yellow	orange
31	*Lagerstroemia indica*	0.94%	731	green	green	green
32	*Erythrophleum africanum*	0.90%	698	green	green	green
33	*Eucalyptus torquata*	0.87%	674	green	green	green
34	*Eucalyptus pauciflora*	0.79%	610	green	yellow	orange
35	*Banksia integrifolia*	0.76%	590	green	green	green
36	*Platanus orientalis*	0.75%	584	green	green	green
37	*Acer negundo*	0.72%	555	yellow	orange	orange
38	*Eucalyptus cladocalyx*	0.71%	552	green	green	yellow
39	*Hakea salicifolia*	0.71%	551	green	green	yellow
40	*Tristaniopsis laurina*	0.70%	545	green	green	green
41	*Zelkova serrata*	0.68%	527	green	green	green
42	*Fraxinus pennsylvanica*	0.68%	526	yellow	orange	orange
43	*Allocasuarina torulosa*	0.57%	445	green	green	yellow
44	*Prunus spp.*	0.49%	376	yellow	yellow	orange
45	*Pyrus betulifolia*	0.45%	351	green	yellow	red
46	*Casuarina cunninghamiana*	0.43%	334	green	green	green
47	*Acer buergerianum*	0.43%	331	green	yellow	orange
48	*Syzygium smithii*	0.41%	320	green	green	green
49	*Grevillea robusta*	0.41%	318	green	green	green
50	*Eucalyptus macrandra*	0.40%	311	green	green	green

Colac-Otway Shire, Victoria

Number of species in dataset: 130
Number of species assessed: 128 (98.5%)
Number of trees in dataset: **3,421**
Number of trees assessed: **3,408 (99.6%)**

Table 41: The proportion of Colac-Otway Shire's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	94%	3%	1%	1%	91%	5%	2%	2%
Emissions limited (RCP4.5 2040)	81%	13%	5%	2%	70%	17%	8%	5%
Business as usual (RCP8.5 2070)	72%	18%	1%	5%	61%	14%	15%	10%

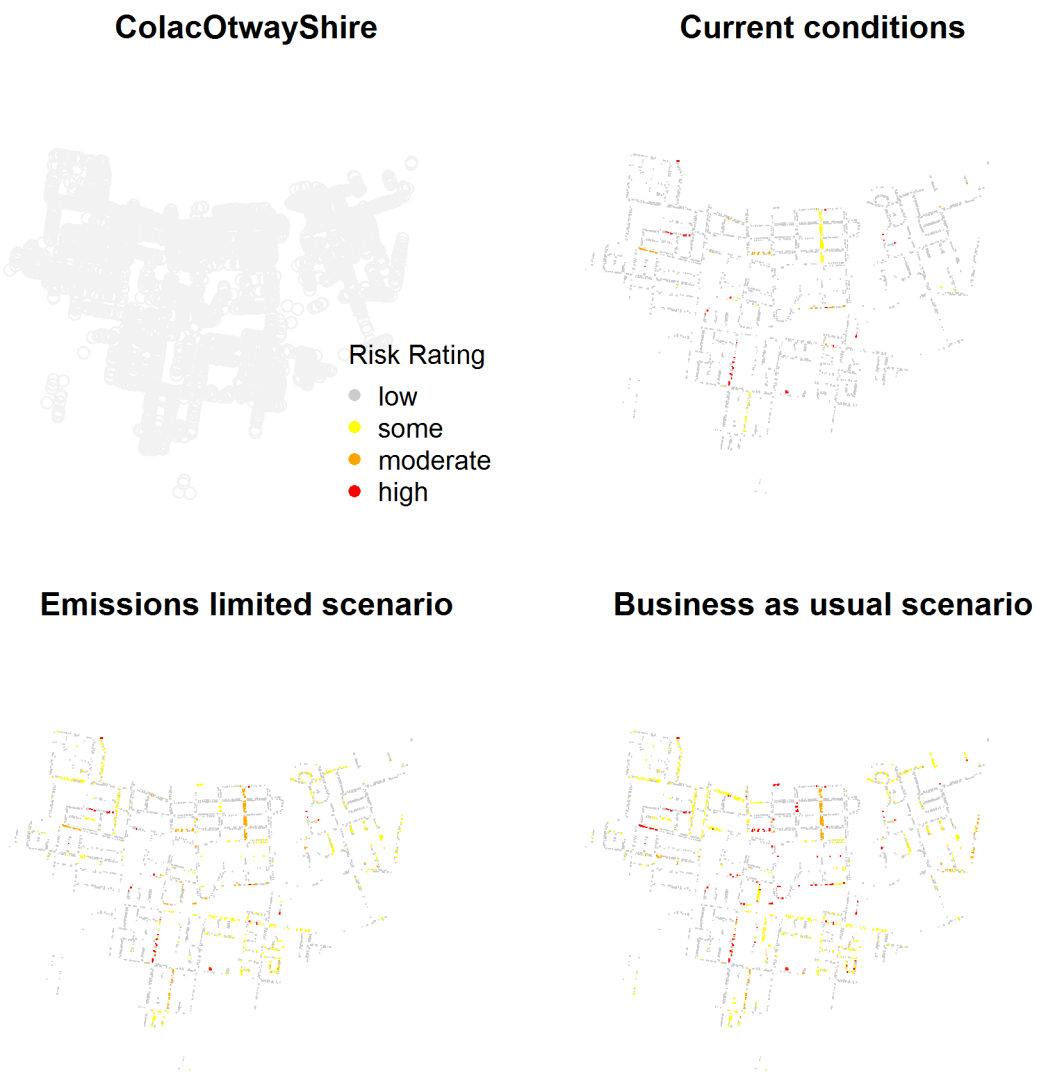

Figure 24: Risk to individual trees within the Colac's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 42: Temperature risk of the most common species in the Colac-Otway Shire.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Lophostemon confertus*	9.65%	329	green	green	green
2	*Agonis flexuosa*	9.36%	319	green	green	green
3	*Prunus × blireiana*	7.72%	263	green	green	green
4	*Fraxinus angustifolia*	7.42%	253	green	green	yellow
5	*Prunus cerasifera*	7.31%	249	green	yellow	yellow
6	*Melaleuca styphelioides*	6.28%	214	green	green	green
7	*Corymbia ficifolia*	3.52%	120	green	green	green
8	*Photinia × fraseri*	3.49%	119	green	green	green
9	*Melaleuca linariifolia*	3.46%	118	green	green	green
10	*Callistemon citrinus*	2.76%	94	green	green	green
11	*Metrosideros excelsa*	2.17%	74	green	green	green
12	*Callistemon viminalis*	2.05%	70	green	green	green
13	*Eucalyptus leucoxylon*	2.02%	69	green	green	green
14	*Platanus orientalis*	1.91%	65	green	green	green
15	*Pyrus ussuriensis*	1.91%	65	green	green	yellow
16	*Quercus robur*	1.85%	63	yellow	orange	orange
17	*Ulmus minor*	1.50%	51	green	orange	red
18	*Prunus serrulata*	1.35%	46	green	yellow	yellow
19	*Hakea salicifolia*	1.32%	45	green	green	green
20	*Fraxinus excelsior*	1.09%	37	orange	orange	red
21	*Eucalyptus cladocalyx*	1.06%	36	green	green	green
22	*Eucalyptus nicholii*	1.00%	34	green	green	yellow
23	*Leptospermum petersonii*	0.97%	33	green	green	green
24	*Betula pubescens*	0.91%	31	red	red	red
25	*Eucalyptus ovata*	0.82%	28	green	yellow	orange
26	*Cupressus macrocarpa*	0.76%	26	green	green	green
27	*Pittosporum undulatum*	0.73%	25	green	green	green
28	*Prunus spp.*	0.70%	24	green	yellow	yellow
29	*Callistemon salignus*	0.67%	23	green	green	green
30	*Eucalyptus botryoides*	0.62%	21	green	green	green
31	*Syzygium smithii*	0.59%	20	green	green	green
32	*Corymbia maculata*	0.56%	19	green	green	green
33	*Malus ioensis*	0.50%	17	green	orange	red
34	*Pittosporum eugenioides*	0.50%	17	green	yellow	yellow
35	*Taxandria juniperina*	0.47%	16	green	green	green
36	*Cotoneaster niger*	0.44%	15	red	red	red
37	*Callitris rhomboidea*	0.41%	14	green	green	green
38	*Viburnum tinus*	0.41%	14	green	green	yellow
39	*Acacia baileyana*	0.38%	13	green	green	green
40	*Lagunaria patersonia*	0.38%	13	green	green	green
41	*Acacia melanoxylon*	0.35%	12	green	green	yellow
42	*Cercis canadensis*	0.32%	11	green	green	green
43	*Eucalyptus camaldulensis*	0.32%	11	green	green	green
44	*Melaleuca armillaris*	0.32%	11	green	green	green
45	*Melaleuca nesophila*	0.32%	11	green	green	green
46	*Banksia marginata*	0.29%	10	green	yellow	orange
47	*Prunus nigra*	0.29%	10	yellow	red	red
48	*Acer negundo*	0.26%	9	green	yellow	orange
49	*Banksia integrifolia*	0.26%	9	green	green	green
50	*Eucalyptus melliodora*	0.26%	9	green	green	green

Corangamite Shire, Victoria

Number of species in dataset: 361
Number of species assessed: 353 (97.8%)
Number of trees in dataset: **15,143**
Number of trees assessed: **14,773 (97.6%)**

Table 43: The proportion of Corangamite Shire's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	92%	7%	1%	0%	87%	8%	5%	0%
Emissions limited (RCP4.5 2040)	65%	24%	11%	1%	71%	14%	11%	4%
Business as usual (RCP8.5 2070)	50%	20%	10%	12%	56%	20%	13%	11%

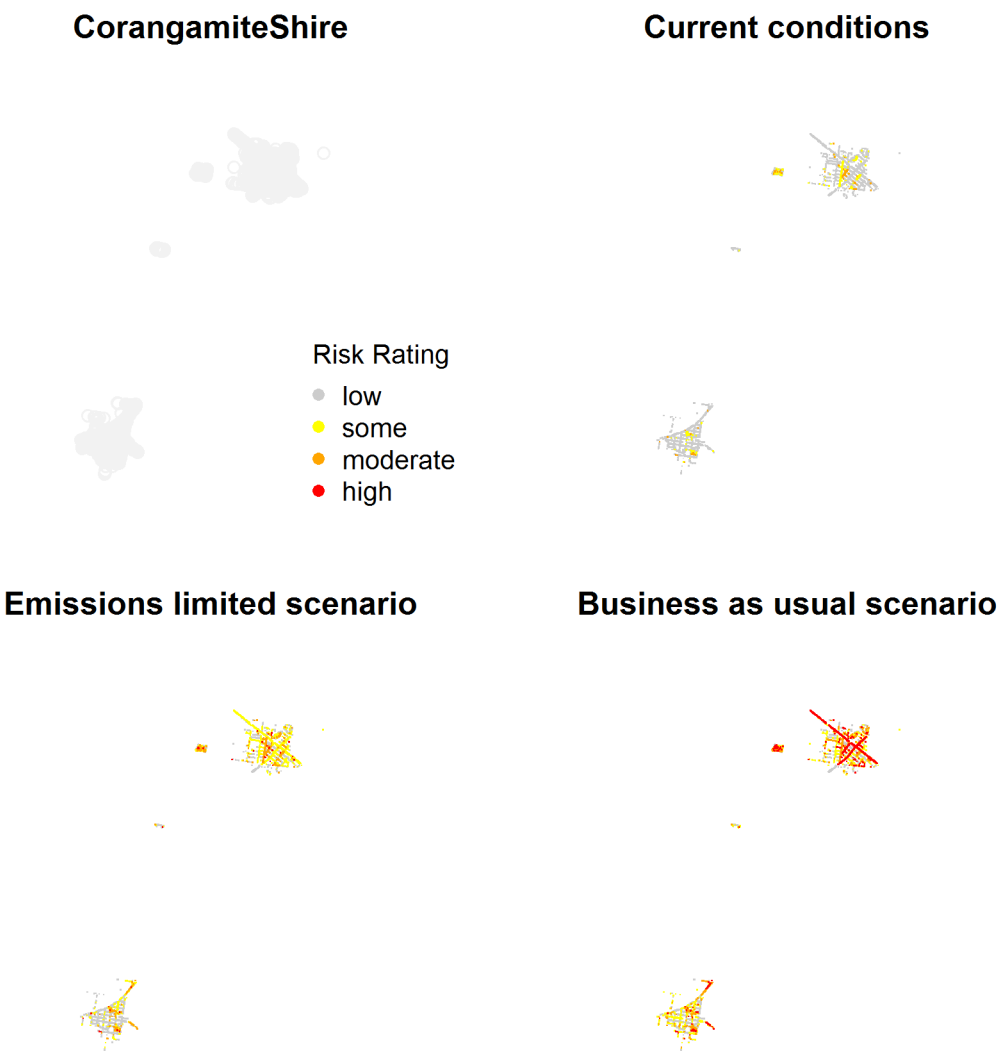

Figure 25: Risk to individual trees within Corangamite Shire's urban forest colour coded for temperature risk under current climate, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 44: Temperature risk of the most common species in Corangamite Shire.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Ulmus minor*	7.27%	1074	green	yellow	red
2	*Eucalyptus leucoxylon*	6.20%	916	green	green	green
3	*Eucalyptus ovata*	5.53%	817	green	yellow	orange
4	*Quercus robur*	5.28%	780	yellow	orange	orange
5	*Fraxinus angustifolia*	4.72%	697	green	green	green
6	*Acacia melanoxylon*	3.75%	554	green	green	yellow
7	*Prunus cerasifera*	3.07%	453	green	yellow	yellow
8	*Eucalyptus viminalis*	2.89%	427	green	yellow	orange
9	*Eucalyptus obliqua*	2.42%	358	green	orange	red
10	*Corymbia ficifolia*	2.12%	313	green	green	green
11	*Agonis flexuosa*	1.97%	291	green	green	green
12	*Eucalyptus camaldulensis*	1.96%	289	green	green	green
13	*Eucalyptus cladocalyx*	1.79%	264	green	green	green
14	*Eucalyptus botryoides*	1.62%	239	green	green	green
15	*Grevillea robusta*	1.48%	218	green	green	green
16	*Callistemon salignus*	1.39%	206	green	green	green
17	*Cupressus macrocarpa*	1.37%	202	green	green	green
18	*Eucalyptus nicholii*	1.37%	202	green	green	yellow
19	*Melaleuca armillaris*	1.34%	198	green	green	green
20	*Melaleuca styphelioides*	1.33%	196	green	green	green
21	*Prunus serrulata*	1.17%	173	green	yellow	yellow
22	*Pinus radiata*	1.07%	158	green	yellow	orange
23	*Eucalyptus kitsoniana*	0.97%	143	green	green	yellow
24	*Lagunaria patersonia*	0.95%	140	green	green	green
25	*Corymbia maculata*	0.90%	133	green	green	green
26	*Eucalyptus globulus*	0.88%	130	green	green	green
27	*Photinia glabra*	0.86%	127	green	green	green
28	*Lophostemon confertus*	0.78%	115	green	green	green
29	*Pittosporum undulatum*	0.78%	115	green	green	green
30	*Callistemon viminalis*	0.76%	113	green	green	green
31	*Corymbia citriodora*	0.75%	111	green	green	green
32	*Casuarina cunninghamiana*	0.74%	110	green	green	green
33	*Allocasuarina verticillata*	0.73%	108	green	green	green
34	*Callistemon citrinus*	0.68%	101	green	green	green
35	*Lagerstroemia indica*	0.66%	97	green	green	green
36	*Salix babylonica*	0.64%	95	green	green	green
37	*Melaleuca linariifolia*	0.64%	94	green	green	green
38	*Banksia integrifolia*	0.62%	92	green	green	green
39	*Angophora costata*	0.60%	88	green	green	green
40	*Platanus acerifolia*	0.60%	88	green	green	yellow
41	*Acacia longifolia*	0.59%	87	green	green	green
42	*Pittosporum tenuifolium*	0.59%	87	green	yellow	orange
43	*Pyrus calleryana*	0.57%	84	green	green	green
44	*Eucalyptus melliodora*	0.56%	83	green	green	green
45	*Betula pendula*	0.55%	81	yellow	orange	orange
46	*Metrosideros excelsa*	0.53%	78	green	green	green
47	*Acacia mearnsii*	0.50%	74	green	green	yellow
48	*Populus × canadensis*	0.50%	74	green	orange	red
49	*Acacia floribunda*	0.49%	72	green	green	green
50	*Acacia baileyana*	0.48%	71	green	green	green

Glenelg Shire Council, Victoria

Number of species in dataset: 37
Number of species assessed: 35 (94.6%)
Number of trees in dataset: **3,758**
Number of trees assessed: **2,874 (76.5%)**

Table 45: The proportion of Glenelg Shire's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	83%	0%	0%	0%	97%	0%	0%	3%
Emissions limited (RCP4.5 2040)	81%	2%	0%	0%	89%	9%	0%	3%
Business as usual (RCP8.5 2070)	63%	19%	0%	0%	69%	26%	3%	3%

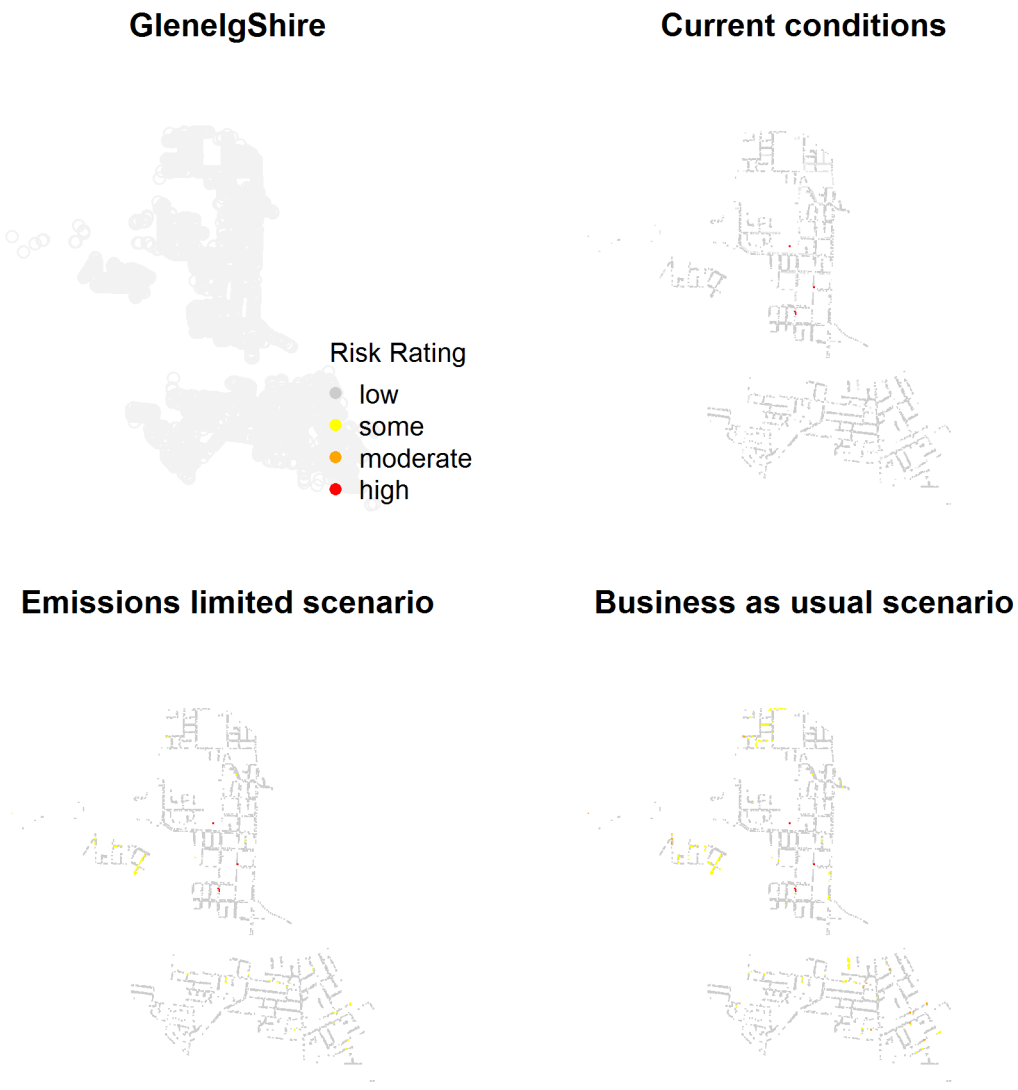

Figure 26: Risk to individual trees within Portland's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 46: Temperature risk of the most common species in Glenelg Shire.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Metrosideros excelsa*	20.88%	600	green	green	green
2	*Unknown*		567			
3	*Callistemon spp.*	17.57%	505	green	green	green
4	*Callistemon viminalis*	8.39%	241	green	green	green
5	*Agonis flexuosa*	6.26%	180	green	green	green
6	*Callistemon salignus*	5.60%	161	green	green	green
7	*Lagunaria patersonia*	5.29%	152	green	green	green
8	*Eucalyptus leucoxylon*	4.07%	117	green	green	green
9	*Araucaria heterophylla*	3.97%	114	green	green	green
10	*Pittosporum revolutum*	3.93%	113	green	green	green
11	*Melaleuca armillaris*	3.83%	110	green	green	green
12	*Melaleuca nesophila*	3.06%	88	green	green	green
13	*Pyrus calleryana*	2.85%	82	green	green	green
14	*Corymbia ficifolia*	2.68%	77	green	green	green
15	*Callistemon citrinus*	2.37%	68	green	green	green
16	*Acacia melanoxylon*	1.18%	34	green	green	yellow
17	*Callistemon macropunctatus*	0.97%	28	green	green	yellow
18	*Eucalyptus viminalis*	0.97%	28	green	yellow	orange
19	*Prunus cerasifera*	0.87%	25	green	yellow	yellow
20	*Eucalyptus macrandra*	0.80%	23	green	green	green
21	*Melaleuca linariifolia*	0.77%	22	green	green	green
22	*Callistemon sieberi*	0.66%	19	green	green	yellow
23	*Hakea laurina*	0.66%	19	green	green	green
24	*Viburnum tinus*	0.66%	19	green	green	yellow
25	*Fraxinus spp.*		17			
26	*Pittosporum eugenioides*	0.31%	9	green	yellow	yellow
27	*Betula pubescens*	0.31%	9	red	red	red
28	*Prunus × blireiana*	0.21%	6	green	green	green
29	*Hakea suaveolens*	0.17%	5	green	green	yellow
30	*Acer buergerianum*	0.14%	4	green	green	yellow
31	*Corynocarpus laevigatus*	0.14%	4	green	green	yellow
32	*Melaleuca lanceolata*	0.14%	4	green	green	green
33	*Banksia integrifolia*	0.10%	3	green	green	green
34	*Lophostemon confertus*	0.07%	2	green	green	green
35	*Angophora costata*	0.03%	1	green	green	green
36	*Brachychiton populneus*	0.03%	1	green	green	green
37	*Photinia × fraseri*	0.03%	1	green	green	green

Greater Shepparton City Council

Number of species in dataset: 376
Number of species assessed: 362 (96.3%)
Number of trees in dataset: **38,678**
Number of trees assessed: **38,213 (98.8%)**

Table 47: The proportion of Shepparton's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	83%	10%	3%	4%	71%	14%	9%	6%
Emissions limited (RCP4.5 2040)	61%	13%	20%	7%	41%	19%	25%	15%
Business as usual (RCP8.5 2070)	22%	20%	14%	22%	19%	14%	24%	43%

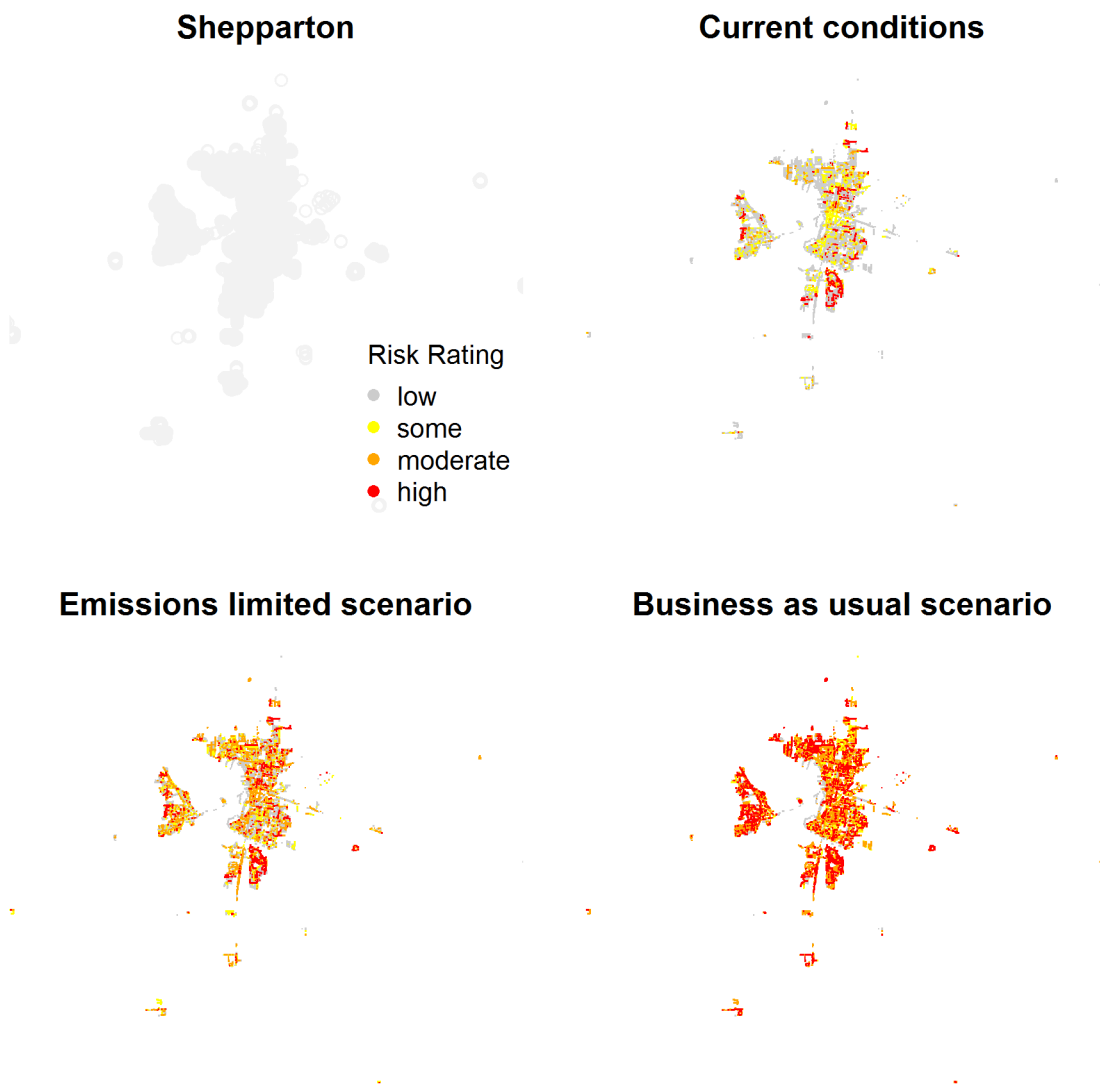

Figure 27: Risk to individual trees within Shepparton's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 48: Temperature risk of the most common species in Shepparton.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	Pyrus calleryana	7.8%	2991	green	green	yellow
2	Eucalyptus camaldulensis	7.2%	2750	green	green	green
3	Eucalyptus leucoxylon	5.3%	2033	green	green	orange
4	Corymbia maculata	3.5%	1355	green	green	orange
5	Melaleuca styphelioides	3.3%	1246	green	green	orange
6	Eucalyptus melliodora	3.0%	1146	green	orange	red
7	Eucalyptus microcarpa	3.0%	1136	green	orange	orange
8	Corymbia citriodora	2.9%	1120	green	green	green
9	Callistemon viminalis	2.8%	1089	green	green	green
10	Acer × freemanii	2.8%	1064	red	red	red
11	Fraxinus angustifolia	2.7%	1043	green	orange	red
12	Lophostemon confertus	2.7%	1029	green	green	yellow
13	Eucalyptus sideroxylon	2.6%	979	green	green	orange
14	Platanus acerifolia	2.3%	875	yellow	orange	orange
15	Melaleuca linariifolia	2.2%	853	green	green	orange
16	Callistemon salignus	2.2%	838	green	green	yellow
17	Corymbia ficifolia	2.2%	830	green	yellow	orange
18	Lagerstroemia indica	1.9%	724	green	green	green
19	Prunus cerasifera	1.8%	704	yellow	orange	orange
20	Tristaniopsis laurina	1.8%	691	green	green	orange
21	Gleditsia triacanthos	1.6%	624	green	yellow	orange
22	Acer negundo	1.4%	546	yellow	orange	orange
23	Callistemon citrinus	1.3%	513	green	green	green
24	Eucalyptus torquata	1.0%	388	green	green	orange
25	Melaleuca armillaris	1.0%	386	green	green	red
26	Pyrus ussuriensis	1.0%	369	green	orange	red
27	Pistacia chinensis	1.0%	364	green	green	green
28	Hymenosporum flavum	0.9%	349	green	green	yellow
29	Ulmus parvifolia	0.9%	341	green	green	yellow
30	Acacia implexa	0.7%	281	green	yellow	orange
31	Fraxinus excelsior	0.7%	274	orange	red	red
32	Jacaranda mimosifolia	0.7%	263	green	green	green
33	Acer rubrum	0.6%	236	yellow	orange	orange
34	Eucalyptus polyanthemos	0.6%	232	green	yellow	red
35	Melia azedarach	0.6%	223	green	green	green
36	Eucalyptus cladocalyx	0.6%	211	green	yellow	red
37	Eucalyptus spp.	0.5%	208	green	yellow	orange
38	Quercus palustris	0.5%	201	orange	orange	red
39	Betula pendula	0.5%	198	orange	red	red
40	Platanus orientalis	0.5%	193	green	green	yellow
41	Angophora costata	0.5%	190	green	green	red
42	Brachychiton populneus	0.5%	181	green	green	yellow
43	Unknown		179			
44	Schinus areira	0.5%	174	green	green	yellow
45	Eucalyptus nicholii	0.5%	172	yellow	yellow	red
46	Cinnamomum camphora	0.4%	149	green	green	green
47	Grevillea robusta	0.4%	201	green	green	green
48	Acer platanoides	0.4%	193	red	red	red
49	Callistemon spp.	0.4%	190	green	green	yellow
50	Quercus coccinea	0.3%	185	orange	red	red

Hobsons Bay City Council, Melbourne

Number of species in dataset: 408
Number of species assessed: 396 (97.1%)
Number of trees in dataset: **67,963**
Number of trees assessed: **67,643 (99.5%)**

Table 49: The proportion of Hobson Bay's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	88%	10%	2%	1%	70%	14%	9%	8%
Emissions limited (RCP4.5 2040)	68%	20%	10%	2%	43%	20%	21%	16%
Business as usual (RCP8.5 2070)	23%	28%	14%	16%	22%	18%	20%	39%

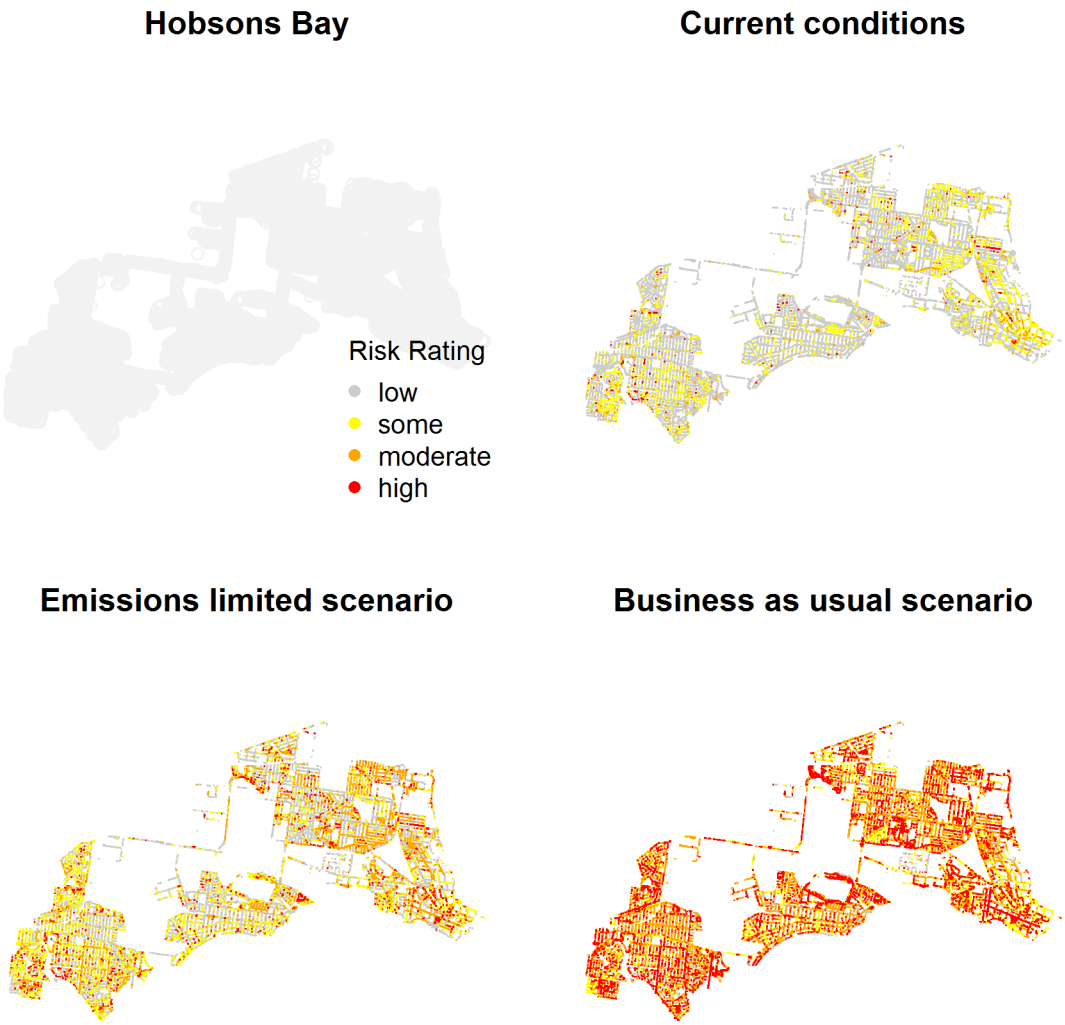

Figure 28: Risk to individual trees within Hobsons Bay's urban forest colour coded for temperature risk under current climate, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 50: Temperature risk of the most common species in Hobsons Bay.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Eucalyptus leucoxylon*	8.62%	5832	green	green	orange
2	*Melaleuca armillaris*	5.70%	3858	green	green	orange
3	*Callistemon viminalis*	4.22%	2856	green	green	green
4	*Eucalyptus camaldulensis*	3.84%	2600	green	green	green
5	*Lophostemon confertus*	3.45%	2337	green	green	green
6	*Corymbia maculata*	3.19%	2160	green	green	yellow
7	*Eucalyptus cladocalyx*	2.98%	2017	green	green	red
8	*Prunus cerasifera*	2.62%	1771	yellow	orange	orange
9	*Melaleuca styphelioides*	2.57%	1737	green	green	yellow
10	*Lagunaria patersonia*	2.56%	1729	green	green	yellow
11	*Allocasuarina verticillata*	2.40%	1621	green	green	yellow
12	*Callistemon salignus*	2.35%	1588	green	green	yellow
13	*Casuarina cunninghamiana*	2.29%	1552	green	green	green
14	*Pyrus calleryana*	2.03%	1372	green	green	yellow
15	*Acacia implexa*	1.96%	1327	green	yellow	orange
16	*Melia azedarach*	1.66%	1124	green	green	green
17	*Fraxinus angustifolia*	1.65%	1113	green	orange	red
18	*Melaleuca linariifolia*	1.61%	1089	green	green	yellow
19	*Ulmus spp.*	1.49%	1007	yellow	yellow	yellow
20	*Callistemon spp.*	1.47%	995	green	green	green
21	*Olea europaea*	1.39%	937	green	green	yellow
22	*Eucalyptus sideroxylon*	1.33%	899	green	green	yellow
23	*Casuarina glauca*	1.23%	831	green	green	green
24	*Melaleuca nesophila*	1.22%	826	green	yellow	orange
25	*Agonis flexuosa*	1.16%	785	green	yellow	orange
26	*Corymbia ficifolia*	1.15%	776	green	yellow	orange
27	*Eucalyptus melliodora*	1.05%	712	green	yellow	red
28	*Myoporum insulare*	0.87%	587	green	yellow	orange
29	*Angophora hispida*	0.85%	572	green	yellow	red
30	*Eucalyptus astringens*	0.82%	558	green	green	yellow
31	*Cupressus macrocarpa*	0.75%	505	green	green	yellow
32	*Tristaniopsis laurina*	0.74%	503	green	green	yellow
33	*Corymbia eximia*	0.73%	497	green	yellow	red
34	*Ulmus parvifolia*	0.72%	486	green	green	yellow
35	*Acacia melanoxylon*	0.68%	462	green	yellow	orange
36	*Lagerstroemia indica*	0.67%	452	green	green	green
37	*Angophora costata*	0.59%	398	green	green	orange
38	*Melaleuca lanceolata*	0.55%	372	green	yellow	red
39	*Eucalyptus mannifera*	0.54%	362	yellow	orange	red
40	*Banksia integrifolia*	0.51%	343	green	green	yellow
41	*Prunus spp.*	0.51%	343	yellow	orange	orange
42	*Araucaria heterophylla*	0.51%	342	green	green	green
43	*Eucalyptus occidentalis*	0.50%	338	green	yellow	red
44	*Pittosporum undulatum*	0.49%	332	green	green	orange
45	*Corymbia citriodora*	0.48%	327	green	green	green
46	*Cupressus × leylandii*	0.47%	317	yellow	yellow	orange
47	*Platanus orientalis*	0.47%	316	green	green	yellow
48	*Eucalyptus spp.*	0.47%	315	green	green	orange
49	*Callistemon citrinus*	0.46%	313	green	green	green
50	*Robinia pseudoacacia*	0.46%	312	yellow	orange	orange

Hume City Council, Melbourne

Number of species in dataset: 493
Number of species assessed: 481 (97.6%)
Number of trees in dataset: **207,171**
Number of trees assessed: **130,580 (63.0%)**

Table 51: The proportion of Hume's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	92%	6%	1%	0%	80%	11%	7%	2%
Emissions limited (RCP4.5 2040)	73%	19%	6%	1%	57%	20%	12%	11%
Business as usual (RCP8.5 2070)	48%	28%	5%	6%	36%	19%	24%	21%

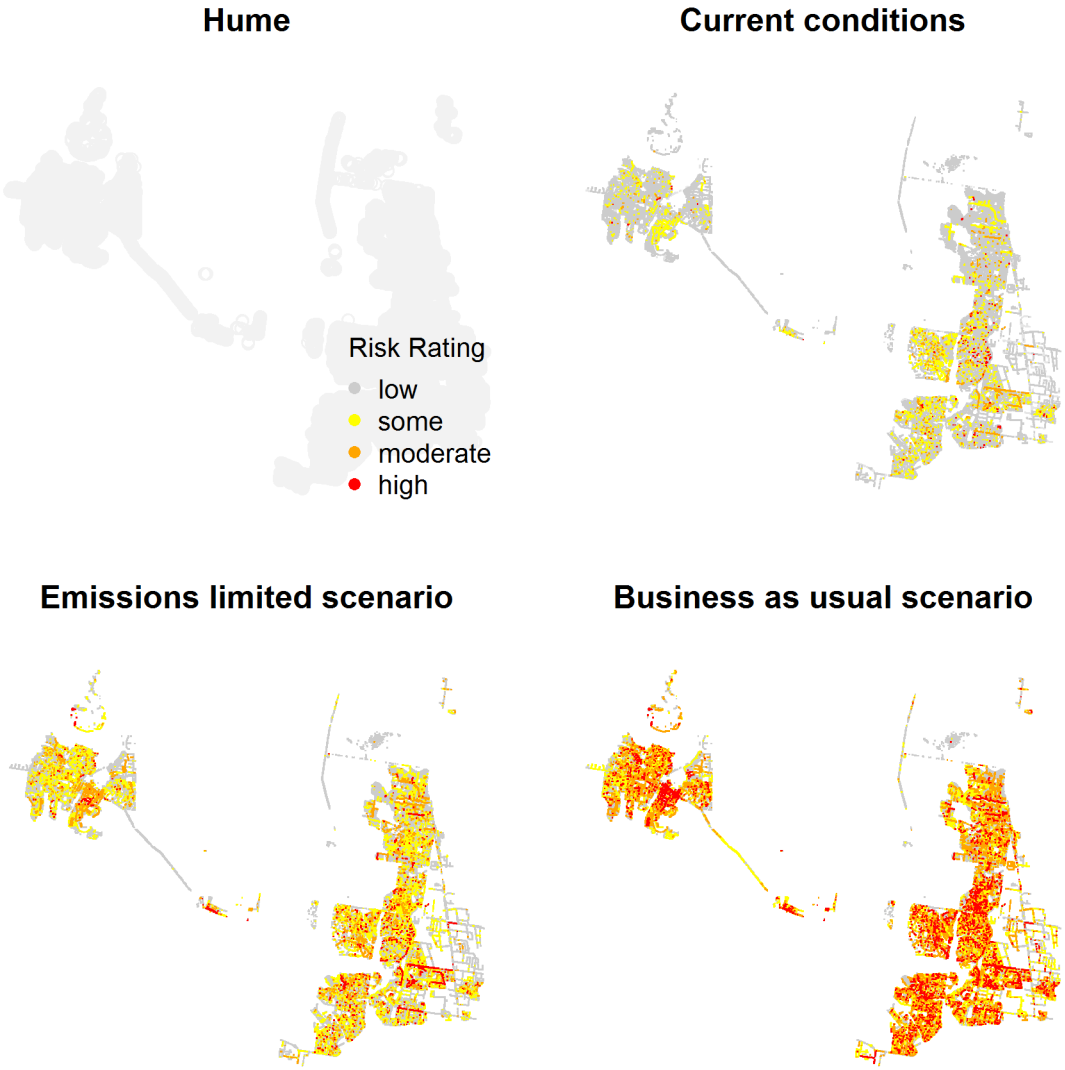

Figure 29: Risk to individual trees within Hume's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 52: Temperature risk of the most common species in Hume.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Eucalyptus leucoxylon*	6.54%	8546	green	green	green
2	*Eucalyptus melliodora*	5.22%	6822	green	green	yellow
3	*Eucalyptus camaldulensis*	5.04%	6580	green	green	green
4	*Pyrus calleryana*	4.57%	5973	green	green	green
5	*Corymbia maculata*	4.14%	5400	green	green	green
6	*Eucalyptus cladocalyx*	3.65%	4765	green	green	green
7	*Eucalyptus polyanthemos*	2.70%	3528	green	green	yellow
8	*Ulmus parvifolia*	2.47%	3226	green	green	green
9	*Callistemon salignus*	2.40%	3130	green	green	green
10	*Acacia melanoxylon*	1.92%	2501	green	yellow	yellow
11	*Melia azedarach*	1.91%	2489	green	green	green
12	*Melaleuca armillaris*	1.83%	2395	green	green	green
13	*Angophora costata*	1.76%	2304	green	green	green
14	*Platanus acerifolia*	1.71%	2228	green	yellow	orange
15	*Eucalyptus sideroxylon*	1.63%	2129	green	green	green
16	*Acacia implexa*	1.48%	1935	green	green	yellow
17	*Fraxinus angustifolia*	1.37%	1795	green	green	orange
18	*Olea europaea*	1.37%	1794	green	green	green
19	*Quercus robur*	1.35%	1760	yellow	orange	orange
20	*Corymbia ficifolia*	1.34%	1749	green	green	yellow
21	*Melaleuca linariifolia*	1.29%	1683	green	green	green
22	*Eucalyptus nicholii*	1.24%	1619	green	yellow	yellow
23	*Eucalyptus mannifera*	1.24%	1618	green	yellow	orange
24	*Callistemon viminalis*	1.18%	1538	green	green	green
25	*Robinia pseudoacacia*	1.17%	1524	green	yellow	orange
26	*Corymbia citriodora*	1.14%	1494	green	green	green
27	*Allocasuarina verticillata*	1.08%	1413	green	green	green
28	*Eucalyptus scoparia*	1.05%	1371	green	yellow	orange
29	*Agonis flexuosa*	1.02%	1333	green	green	yellow
30	*Prunus cerasifera*	1.01%	1321	yellow	yellow	orange
31	*Quercus palustris*	0.97%	1269	yellow	orange	orange
32	*Eucalyptus viminalis*	0.97%	1265	green	yellow	orange
33	*Cupressus macrocarpa*	0.96%	1260	green	green	yellow
34	*Melaleuca styphelioides*	0.96%	1251	green	green	green
35	*Lophostemon confertus*	0.92%	1205	green	green	green
36	*Casuarina cunninghamiana*	0.91%	1191	green	green	green
37	*Pinus radiata*	0.90%	1175	green	yellow	orange
38	*Eucalyptus microcarpa*	0.87%	1134	green	green	yellow
39	*Gleditsia triacanthos*	0.85%	1112	green	green	yellow
40	*Hakea salicifolia*	0.83%	1089	green	green	yellow
41	*Callistemon spp.*	0.81%	1060	green	green	green
42	*Ulmus minor*	0.73%	956	green	orange	red
43	*Eucalyptus botryoides*	0.67%	878	green	green	yellow
44	*Acacia mearnsii*	0.67%	869	green	yellow	orange
45	*Lagerstroemia indica*	0.65%	848	green	green	green
46	*Koelreuteria paniculata*	0.63%	817	green	yellow	yellow
47	*Tristaniopsis laurina*	0.61%	802	green	green	yellow
48	*Acer campestre*	0.54%	711	orange	red	red
49	*Eucalyptus spp.*	0.49%	644	green	green	yellow
50	*Eucalyptus spathulata*	0.49%	642	green	green	green

Manningham City Council, Melbourne

Number of species in dataset: 449
Number of species assessed: 426 (94.9%)
Number of trees in dataset: **68,872**
Number of trees assessed: **58,347 (84.7%)**

Table 53: The proportion of Manningham's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	71%	22%	5%	1%	71%	15%	9%	6%
Emissions limited (RCP4.5 2040)	47%	30%	18%	4%	43%	23%	20%	14%
Business as usual (RCP8.5 2070)	21%	23%	14%	20%	23%	17%	24%	36%

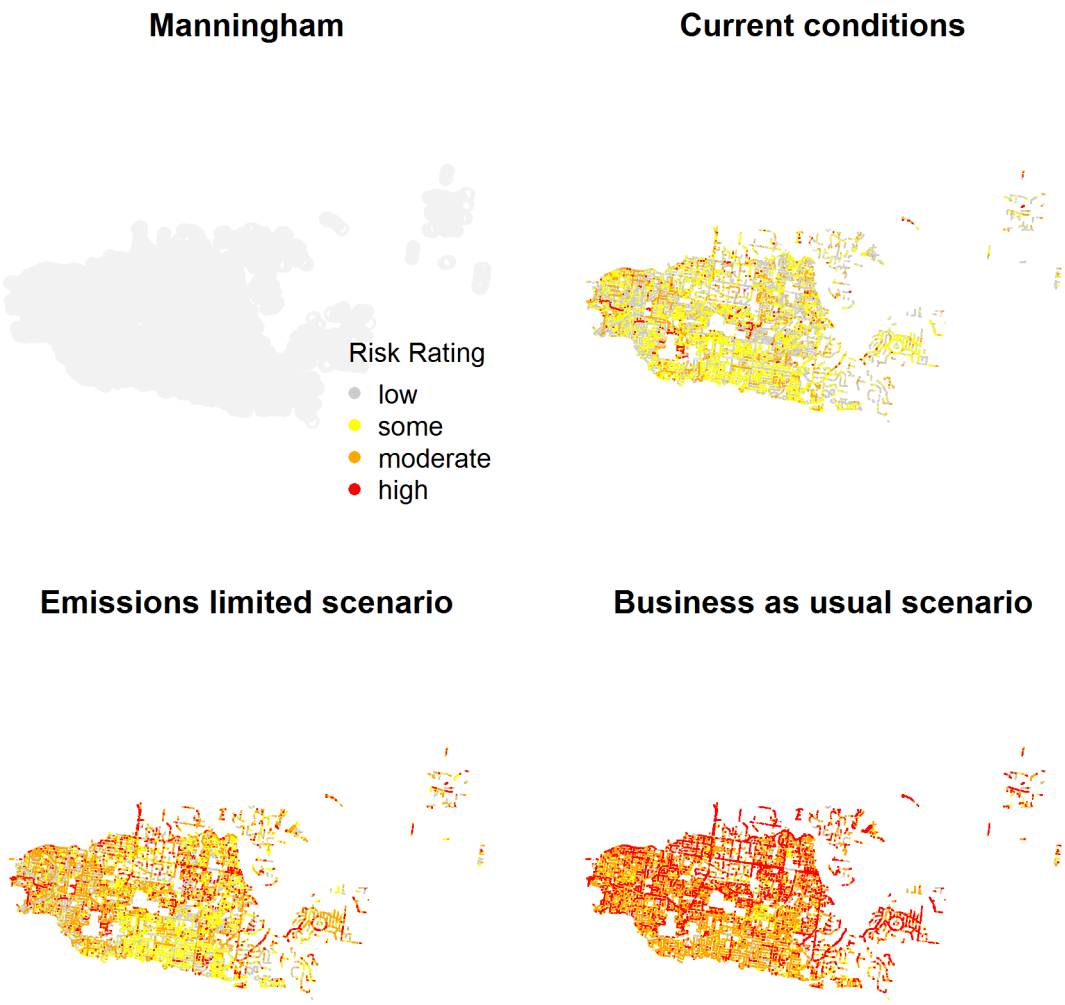

Figure 30: Risk to individual trees within Manningham's urban forest colour coded for temperature risk under current climate, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 54: Temperature risk of the most common species in Manningham.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Prunus cerasifera*	6.64%	3873	yellow	yellow	orange
2	*Lophostemon confertus*	6.52%	3805	green	green	green
3	*Eucalyptus polyanthemos*	4.39%	2563	green	yellow	orange
4	*Melaleuca linariifolia*	4.15%	2422	green	green	yellow
5	*Melaleuca styphelioides*	3.97%	2319	green	green	yellow
6	*Pyrus calleryana*	3.81%	2224	green	green	yellow
7	*Corymbia ficifolia*	3.21%	1871	green	yellow	orange
8	*Tristaniopsis laurina*	3.18%	1856	green	green	orange
9	*Eucalyptus melliodora*	2.92%	1703	green	yellow	red
10	*Callistemon viminalis*	2.51%	1463	green	green	green
11	*Syzygium floribundum*	2.33%	1358	green	green	green
12	*Pinus radiata*	2.28%	1331	yellow	orange	red
13	*Quercus palustris*	1.56%	908	orange	orange	red
14	*Callistemon salignus*	1.48%	864	green	green	green
15	*Unknown*		825			
16	*Eucalyptus goniocalyx*	1.39%	809	green	orange	red
17	*Lagerstroemia indica*	1.32%	773	green	green	green
18	*Prunus spp.*	1.19%	697	yellow	yellow	orange
19	*Eucalyptus spp.*	1.17%	682	green	yellow	orange
20	*Melaleuca armillaris*	1.15%	673	green	green	orange
21	*Olea europaea*	1.15%	671	green	green	yellow
22	*Acacia melanoxylon*	1.10%	643	green	yellow	orange
23	*Callistemon citrinus*	1.09%	635	green	green	green
24	*Callistemon spp.*	1.08%	632	green	green	green
25	*Prunus serrulata*	1.05%	614	yellow	yellow	orange
26	*Melia azedarach*	1.04%	605	green	green	green
27	*Eucalyptus nicholii*	0.94%	547	green	yellow	orange
28	*Pittosporum undulatum*	0.93%	541	green	green	orange
29	*Ulmus parvifolia*	0.92%	536	green	green	green
30	*Hakea salicifolia*	0.88%	514	green	yellow	orange
31	*Betula pendula*	0.87%	509	orange	red	red
32	*Acer rubrum*	0.87%	505	yellow	orange	orange
33	*Corymbia maculata*	0.85%	495	green	green	yellow
34	*Gleditsia triacanthos*	0.84%	489	green	yellow	yellow
35	*Acacia implexa*	0.82%	476	green	yellow	orange
36	*Agonis flexuosa*	0.81%	474	green	yellow	orange
37	*Eucalyptus mannifera*	0.80%	467	yellow	orange	red
38	*Pyrus spp.*	0.79%	461	green	green	yellow
39	*Eucalyptus leucoxylon*	0.79%	459	green	green	orange
40	*Robinia pseudoacacia*	0.77%	449	yellow	orange	orange
41	*Eucalyptus camaldulensis*	0.72%	422	green	green	green
42	*Fraxinus angustifolia*	0.70%	406	green	orange	orange
43	*Liquidambar styraciflua*	0.66%	387	green	green	green
44	*Prunus × blireiana*	0.62%	359	green	orange	red
45	*Platanus acerifolia*	0.58%	340	green	yellow	orange
46	*Eucalyptus macrorhyncha*	0.53%	311	yellow	red	red
47	*Eucalyptus ovata*	0.49%	285	yellow	red	red
48	*Corymbia citriodora*	0.47%	273	green	green	green
49	*Acacia spp.*	0.45%	261	green	yellow	orange
50	*Eucalyptus sideroxylon*	0.44%	258	green	green	yellow

Marrickville (Inner West Council), Sydney

Number of species in dataset: 413
Number of species assessed: 400 (96.9%)
Number of trees in dataset: **34,935**
Number of trees assessed: **31,682 (90.7%)**

Table 55: The proportion of Marrickvilles's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	54%	18%	21%	8%	32%	14%	22%	33%
Emissions limited (RCP4.5 2040)	44%	12%	21%	22%	24%	13%	20%	44%
Business as usual (RCP8.5 2070)	29%	19%	5%	40%	15%	8%	19%	58%

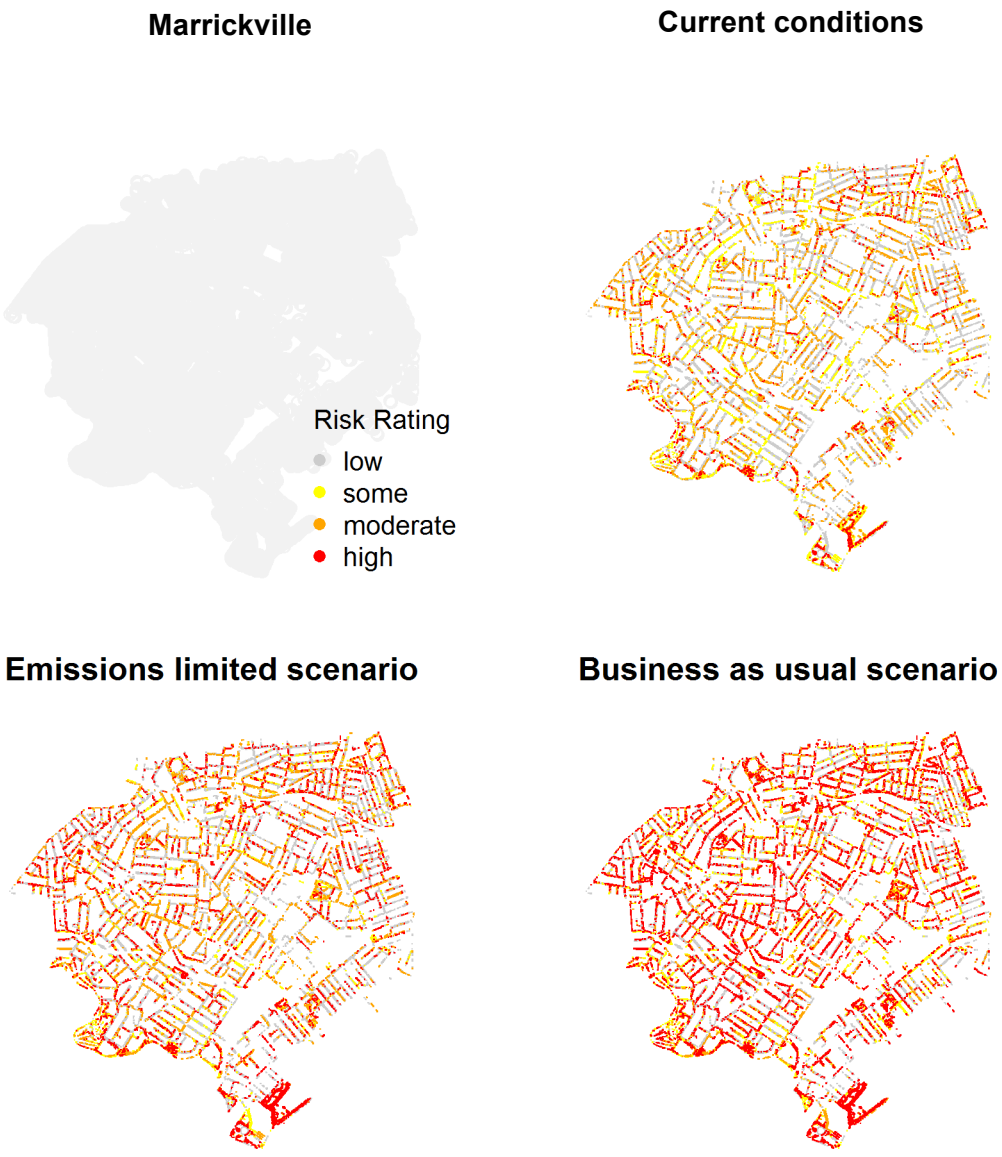

Figure 31: Risk to individual trees within Marrickville's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 56: Temperature risk of the most common species in Marrickville.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Callistemon viminalis*	12.48%	3953	green	green	green
2	*Melaleuca bracteata*	7.32%	2318	green	green	green
3	*Tristaniopsis laurina*	6.11%	1935	orange	orange	red
4	*Casuarina cunninghamiana*	4.14%	1312	green	yellow	yellow
5	*Lophostemon confertus*	4.05%	1282	yellow	orange	red
6	*Casuarina glauca*	3.95%	1250	yellow	red	red
7	*Fraxinus griffithii*	3.90%	1236	green	green	yellow
8	*Lagerstroemia indica*	3.71%	1176	green	green	green
9	*Elaeocarpus reticulatus*	3.06%	969	orange	red	red
10	*Melaleuca quinquenervia*	2.18%	692	green	green	yellow
11	*Pyrus calleryana*	1.91%	605	yellow	orange	red
12	*Syzygium smithii*	1.63%	517	orange	red	red
13	*Sapium sebiferum*	1.62%	513	green	green	yellow
14	*Leptospermum petersonii*	1.48%	469	orange	red	red
15	*Cupaniopsis anacardioides*	1.46%	461	green	green	green
16	*Pistacia chinensis*	1.19%	378	green	yellow	orange
17	*Stenocarpus sinuatus*	1.16%	368	green	yellow	orange
18	*Jacaranda mimosifolia*	1.04%	329	green	green	yellow
19	*Melaleuca linariifolia*	1.04%	329	orange	red	red
20	*Syzygium luehmannii*	1.04%	328	green	green	yellow
21	*Eucalyptus robusta*	0.93%	296	green	green	yellow
22	*Callistemon spp.*	0.91%	289	green	green	green
23	*Allocasuarina verticillata*	0.79%	249	yellow	orange	red
24	*Eucalyptus saligna*	0.74%	233	yellow	orange	red
25	*Auranticarpa rhombifolia*	0.71%	226	green	yellow	orange
26	*Eucalyptus nicholii*	0.71%	226	red	red	red
27	*Corymbia maculata*	0.70%	222	orange	orange	red
28	*Prunus cerasifera*	0.69%	220	orange	orange	red
29	*Ficus microcarpa*	0.69%	219	green	green	green
30	*Olea europaea*	0.67%	213	yellow	orange	orange
31	*Corymbia citriodora*	0.64%	202	green	green	green
32	*Cinnamomum camphora*	0.62%	195	green	green	orange
33	*Ficus rubiginosa*	0.61%	192	yellow	yellow	yellow
34	*Corymbia ficifolia*	0.60%	191	orange	red	red
35	*Backhousia citriodora*	0.59%	188	green	green	green
36	*Lagunaria patersonia*	0.55%	174	orange	orange	orange
37	*Podocarpus elatus*	0.54%	172	green	yellow	orange
38	*Angophora costata*	0.54%	170	red	red	red
39	*Callistemon salignus*	0.53%	169	yellow	red	red
40	*Koelreuteria paniculata*	0.53%	168	yellow	orange	orange
41	*Acacia decurrens*	0.53%	168	red	red	red
42	*Syncarpia glomulifera*	0.52%	165	orange	red	red
43	*Robinia pseudoacacia*	0.49%	156	red	red	red
44	*Eucalyptus tereticornis*	0.47%	150	green	green	green
45	*Phoenix canariensis*	0.47%	149	green	green	orange
46	*Acacia salicina*	0.45%	144	green	green	orange
47	*Eucalyptus microcorys*	0.45%	142	orange	red	red
48	*Buckinghamia celsissima*	0.43%	137	green	green	yellow
49	*Syzygium australe*	0.37%	116	yellow	yellow	orange
50	*Allocasuarina littoralis*	0.37%	116	orange	orange	orange

Maroondah City Council, Melbourne

Number of species in dataset: 375
Number of species assessed: 367 (97.8%)
Number of trees in dataset: **64,286**
Number of trees assessed: **63,686 (99.1%)**

Table 57: The proportion of Maroondah's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	86%	10%	3%	0%	69%	16%	10%	5%
Emissions limited (RCP4.5 2040)	59%	23%	16%	4%	44%	22%	19%	14%
Business as usual (RCP8.5 2070)	32%	26%	9%	19%	24%	16%	26%	34%

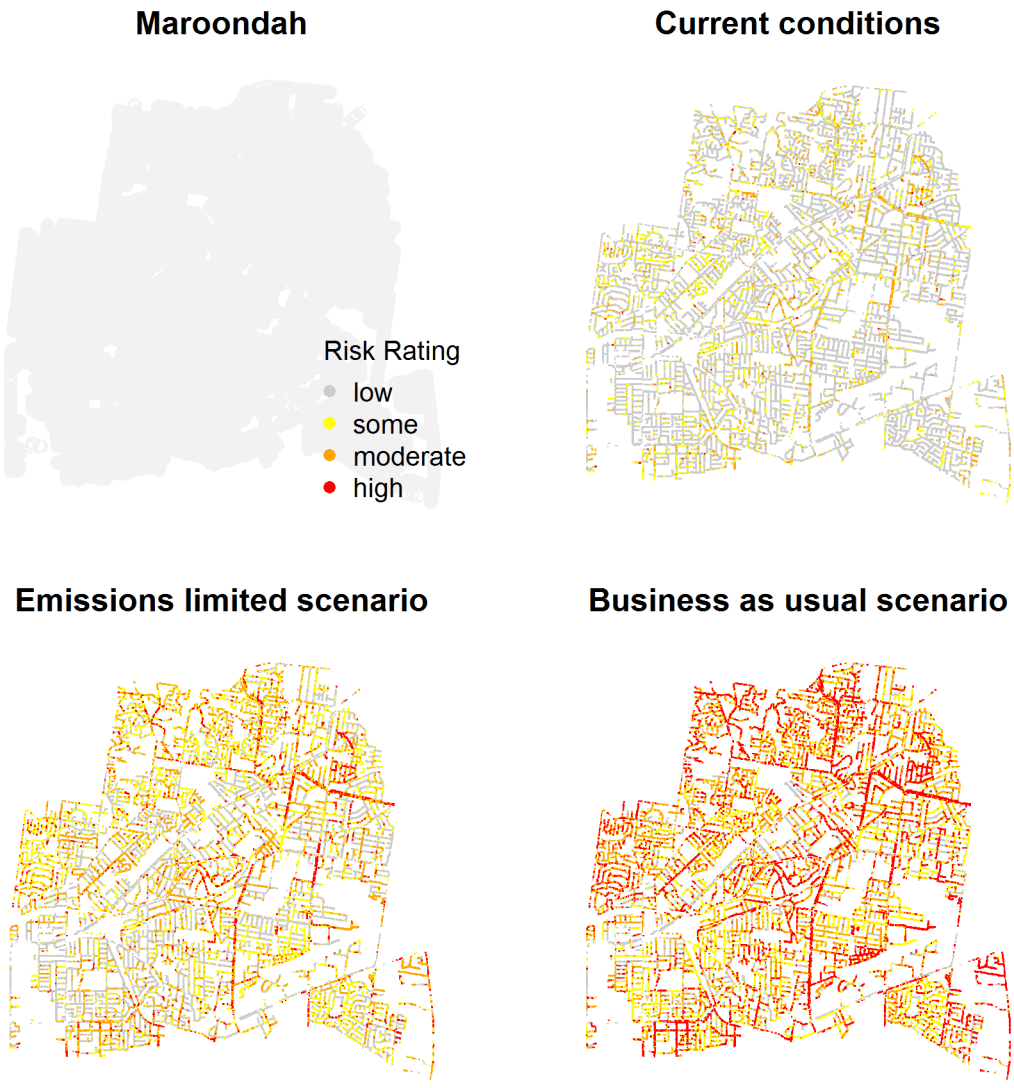

Figure 32: Risk to individual trees within Maroondah's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 58: Temperature risk of the most common species in Maroondah.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Lophostemon confertus*	8.43%	5369	green	green	green
2	*Melaleuca linariifolia*	8.13%	5176	green	green	yellow
3	*Lagerstroemia indica*	5.17%	3294	green	green	green
4	*Callistemon viminalis*	3.91%	2489	green	green	green
5	*Tristaniopsis laurina*	3.77%	2404	green	green	yellow
6	*Agonis flexuosa*	3.53%	2245	green	yellow	orange
7	*Liquidambar styraciflua*	3.23%	2054	green	green	green
8	*Callistemon salignus*	3.09%	1966	green	green	green
9	*Eucalyptus cephalocarpa*	3.08%	1964	green	orange	red
10	*Melaleuca styphelioides*	2.83%	1805	green	green	yellow
11	*Eucalyptus radiata*	2.55%	1624	green	orange	red
12	*Melaleuca bracteata*	2.46%	1569	green	green	green
13	*Corymbia ficifolia*	2.36%	1500	green	yellow	orange
14	*Eucalyptus spp.*	2.18%	1387	green	yellow	orange
15	*Eucalyptus leucoxylon*	2.13%	1358	green	green	yellow
16	*Eucalyptus polyanthemos*	2.12%	1349	green	yellow	orange
17	*Eucalyptus nicholii*	2.03%	1295	green	yellow	orange
18	*Eucalyptus melliodora*	1.92%	1221	green	yellow	orange
19	*Prunus cerasifera*	1.66%	1056	yellow	yellow	orange
20	*Fraxinus angustifolia*	1.37%	870	green	orange	orange
21	*Eucalyptus goniocalyx*	1.29%	821	green	orange	red
22	*Pittosporum undulatum*	1.22%	777	green	green	orange
23	*Allocasuarina littoralis*	1.09%	695	green	green	yellow
24	*Syzygium smithii*	1.01%	642	green	green	yellow
25	*Eucalyptus obliqua*	1.01%	642	orange	red	red
26	*Eucalyptus sideroxylon*	0.99%	630	green	green	yellow
27	*Acacia implexa*	0.83%	527	green	green	orange
28	*Eucalyptus ovata*	0.82%	525	yellow	red	red
29	*Callistemon spp.*	0.80%	512	green	green	green
30	*Eucalyptus scoparia*	0.77%	493	green	yellow	red
31	*Acacia melanoxylon*	0.74%	474	green	yellow	orange
32	*Acacia spp.*	0.73%	466	green	yellow	orange
33	*Betula pendula*	0.70%	447	orange	orange	red
34	*Prunus × blireiana*	0.60%	380	green	green	red
35	*Eucalyptus cladocalyx*	0.57%	365	green	green	yellow
36	*Eucalyptus globoidea*	0.57%	364	green	yellow	red
37	*Melaleuca armillaris*	0.56%	357	green	green	yellow
38	*Pyrus calleryana*	0.56%	357	green	green	green
39	*Unknown*		332			
40	*Eucalyptus macrorhyncha*	0.44%	282	yellow	red	red
41	*Quercus palustris*	0.44%	280	yellow	orange	orange
42	*Gleditsia triacanthos*	0.42%	270	green	yellow	yellow
43	*Hakea salicifolia*	0.42%	268	green	green	orange
44	*Angophora costata*	0.42%	265	green	green	yellow
45	*Cotoneaster glaucophyllus*	0.40%	254	green	yellow	orange
46	*Pinus radiata*	0.39%	248	yellow	orange	red
47	*Callistemon citrinus*	0.38%	239	green	green	green
48	*Photinia bodinieri*	0.37%	238	green	green	green
49	*Corymbia maculata*	0.37%	237	green	green	yellow
50	*Prunus spp.*	0.37%	236	yellow	yellow	orange

Moonee Valley City Council, Melbourne

Number of species in dataset: 233
Number of species assessed: 192 (82.4%)
Number of trees in dataset: **44,033**
Number of trees assessed: **41,431 (94.1%)**

Table 59: The proportion of Moonee Valley's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	63%	21%	8%	6%	66%	20%	7%	7%
Emissions limited (RCP4.5 2040)	46%	23%	21%	9%	43%	22%	21%	14%
Business as usual (RCP8.5 2070)	13%	28%	24%	22%	19%	21%	28%	32%

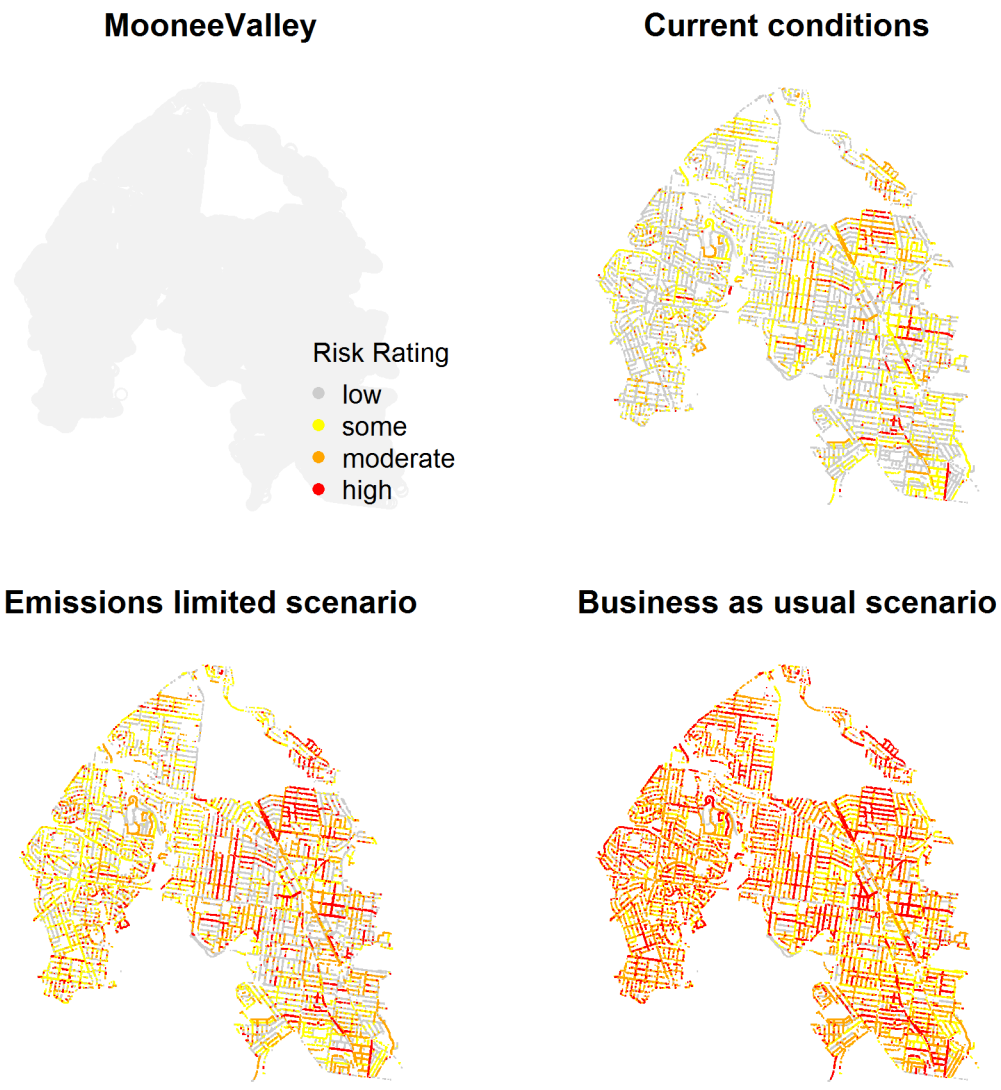

Figure 33: Risk to individual trees within Moonee Valley's urban forest colour coded for temperature risk under current climate, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 60: Temperature risk of the most common species in Moonee Valley.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Lophostemon confertus*	11.39%	4719	green	green	yellow
2	*Corymbia ficifolia*	4.71%	1951	green	yellow	orange
3	*Platanus acerifolia*	4.51%	1867	yellow	orange	orange
4	*Prunus cerasifera*	4.13%	1711	yellow	orange	orange
5	*Jacaranda mimosifolia*	4.01%	1660	green	green	green
6	*Fraxinus spp.*	3.97%	1646	orange	red	red
7	*Unknown*	3.93%	1629			
8	*Olea spp.*	3.69%	1528	green	green	yellow
9	*Pyrus calleryana*	3.58%	1483	green	green	yellow
10	*Callistemon spp.*	3.51%	1453	green	green	yellow
11	*Eucalyptus spp.*	3.24%	1344	green	yellow	orange
12	*Eucalyptus leucoxylon*	3.11%	1289	green	yellow	orange
13	*Melaleuca linariifolia*	2.51%	1041	green	green	orange
14	*Lagerstroemia indica*	2.28%	946	green	green	green
15	*Melaleuca styphelioides*	1.97%	817	green	green	orange
16	*Corymbia maculata*	1.83%	759	green	yellow	orange
17	*Melia azedarach*	1.73%	718	green	green	green
18	*Pyrus ussuriensis*	1.67%	692	yellow	orange	red
19	*Angophora costata*	1.41%	585	green	yellow	red
20	*Platanus orientalis*	1.38%	571	green	green	yellow
21	*Lagunaria patersonia*	1.38%	570	green	green	orange
22	*Betula pendula*	1.37%	566	orange	red	red
23	*Fraxinus excelsior*	1.23%	510	red	red	red
24	*Agonis flexuosa*	1.16%	482	green	yellow	red
25	*Eucalyptus nicholii*	1.12%	466	yellow	yellow	red
26	*Melaleuca armillaris*	1.12%	463	green	yellow	red
27	*Robinia pseudoacacia*	1.11%	461	yellow	orange	red
28	*Syzygium smithii*	1.05%	436	green	green	orange
29	*Acer spp.*	0.94%	389	yellow	orange	orange
30	*Pyrus spp.*	0.94%	388	green	yellow	orange
31	*Prunus spp.*	0.93%	384	yellow	orange	orange
32	*Phoenix canariensis*	0.89%	367	green	green	green
33	*Eucalyptus scoparia*	0.85%	352	yellow	orange	red
34	*Callistemon viminalis*	0.78%	325	green	green	green
35	*Acer rubrum*	0.77%	321	yellow	orange	orange
36	*Cupressus spp.*	0.77%	319	green	yellow	yellow
37	*Lagerstroemia spp.*	0.76%	314	green	green	green
38	*Fraxinus pennsylvanica*	0.75%	309	orange	orange	orange
39	*Pittosporum undulatum*	0.72%	300	green	yellow	orange
40	*Ulmus minor*	0.67%	278	red	red	red
41	*Eucalyptus sideroxylon*	0.65%	269	green	green	orange
42	*Callistemon salignus*	0.62%	257	green	green	yellow
43	*Tristaniopsis laurina*	0.56%	234	green	yellow	orange
44	*Grevillea robusta*	0.52%	214	green	green	green
45	*Melaleuca spp.*	0.51%	213	green	green	orange
46	*Quercus robur*	0.46%	189	orange	red	red
47	*Hakea spp.*	0.46%	189			
48	*Cinnamomum camphora*	0.42%	176	green	green	green
49	*Photinia bodinieri*	0.41%	168	green	green	yellow
50	*Ulmus spp.*	0.41%	168	orange	red	red

Moreland City Council, Melbourne

Number of species in dataset: 351
Number of species assessed: 341 (97.2%)
Number of trees in dataset: **73,958**
Number of trees assessed: **54,300 (73.4%)**

Table 61: The proportion of Morelands's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	77%	18%	2%	2%	63%	18%	12%	7%
Emissions limited (RCP4.5 2040)	48%	30%	16%	6%	36%	20%	25%	19%
Business as usual (RCP8.5 2070)	16%	26%	11%	26%	19%	15%	23%	43%

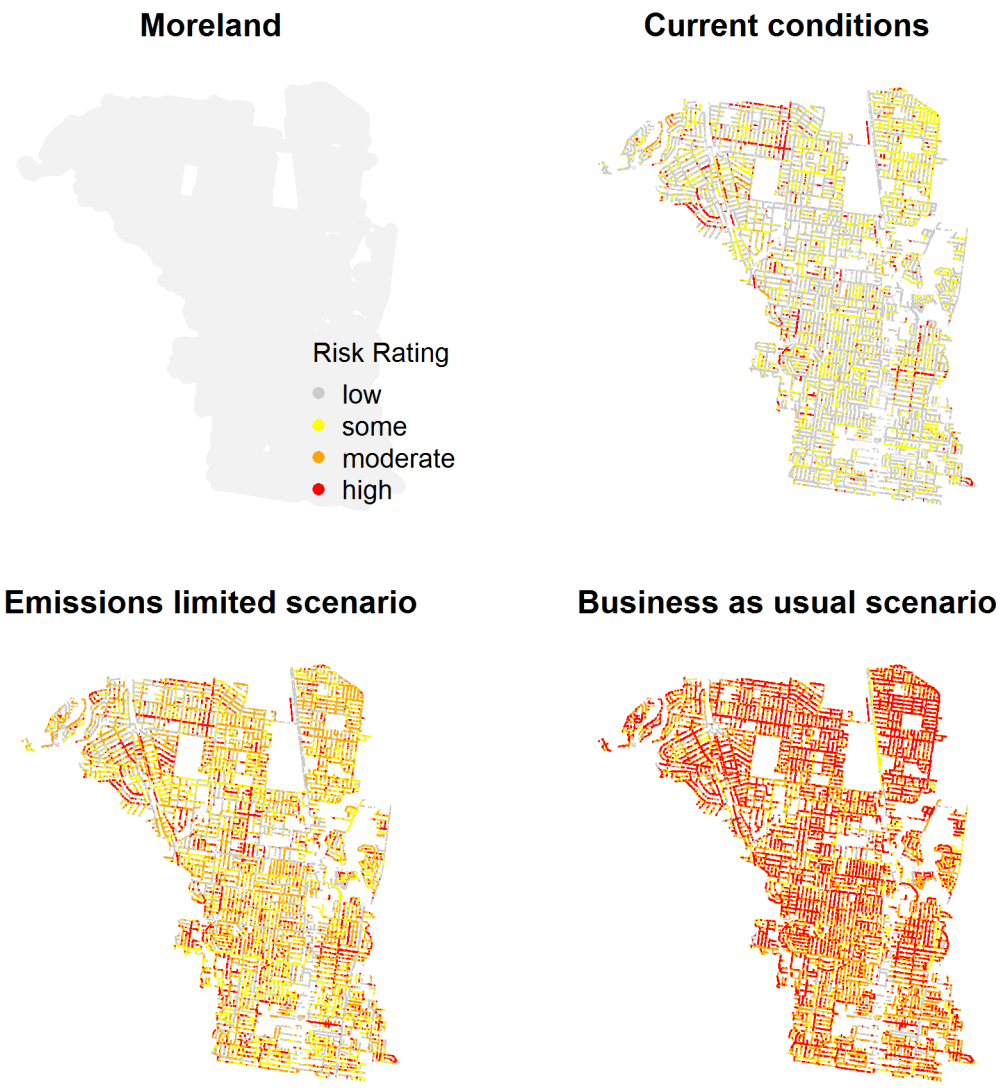

Figure 34: Risk to individual trees within Moreland's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 62: Temperature risk of the most common species in Moreland.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Eucalyptus leucoxylon*	9.17%	4978	green	yellow	orange
2	*Callistemon salignus*	7.94%	4311	green	green	yellow
3	*Callistemon viminalis*	7.38%	4008	green	green	green
4	*Melaleuca linariifolia*	5.29%	2870	green	yellow	orange
5	*Callistemon spp.*	4.68%	2542	green	green	yellow
6	*Lophostemon confertus*	3.45%	1872	green	green	yellow
7	*Olea europaea*	3.05%	1657	green	green	yellow
8	*Eucalyptus polyanthemos*	2.84%	1543	green	yellow	red
9	*Pyrus calleryana*	2.60%	1413	green	green	yellow
10	*Acacia implexa*	2.48%	1348	green	orange	orange
11	*Agonis flexuosa*	2.48%	1344	green	yellow	red
12	*Prunus × blireiana*	2.16%	1175	green	red	red
13	*Angophora costata*	2.02%	1099	green	yellow	red
14	*Eucalyptus mannifera*	1.91%	1035	yellow	orange	red
15	*Melia azedarach*	1.81%	983	green	green	green
16	*Tristaniopsis laurina*	1.64%	891	green	yellow	orange
17	*Callistemon sieberi*	1.51%	819	yellow	orange	red
18	*Eucalyptus sideroxylon*	1.46%	791	green	green	orange
19	*Prunus spp.*	1.37%	743	yellow	orange	red
20	*Eucalyptus torquata*	1.35%	732	green	green	orange
21	*Malus ioensis*	1.32%	716	red	red	red
22	*Prunus cerasifera*	1.24%	676	yellow	orange	orange
23	*Lagerstroemia indica*	1.19%	646	green	green	green
24	*Callistemon citrinus*	1.03%	559	green	green	green
25	*Acacia melanoxylon*	1.00%	545	yellow	orange	orange
26	*Eucalyptus scoparia*	1.00%	541	yellow	orange	red
27	*Hakea salicifolia*	0.92%	499	green	yellow	orange
28	*Ficus microcarpa*	0.89%	482	green	green	green
29	*Hymenosporum flavum*	0.87%	472	green	green	yellow
30	*Melaleuca styphelioides*	0.81%	442	green	green	orange
31	*Corymbia ficifolia*	0.81%	438	green	yellow	orange
32	*Acer negundo*	0.75%	409	yellow	orange	orange
33	Unknown		406			
34	*Pyrus ussuriensis*	0.70%	380	yellow	orange	red
35	*Platanus acerifolia*	0.66%	360	yellow	orange	orange
36	*Allocasuarina verticillata*	0.64%	349	green	green	yellow
37	*Fraxinus angustifolia*	0.64%	349	green	orange	red
38	*Eucalyptus nicholii*	0.64%	345	yellow	yellow	red
39	*Eucalyptus spp.*	0.63%	344	green	yellow	orange
40	*Pittosporum undulatum*	0.62%	336	green	yellow	orange
41	*Eucalyptus melliodora*	0.50%	271	green	orange	red
42	*Callistemon macropunctatus*	0.47%	254	green	orange	red
43	*Eriobotrya japonica*	0.45%	247	green	green	green
44	*Melaleuca armillaris*	0.45%	243	green	yellow	red
45	*Casuarina cunninghamiana*	0.43%	234	green	green	green
46	*Jacaranda mimosifolia*	0.38%	207	green	green	green
47	*Syzygium smithii*	0.36%	197	green	green	orange
48	*Nerium oleander*	0.34%	186	green	green	green
49	*Corymbia maculata*	0.33%	181	green	yellow	orange
50	*Robinia pseudoacacia*	0.31%	167	yellow	orange	red

Southern Grampians Shire, Victoria

Number of species in dataset: 135
Number of species assessed: 117 (87.7%)
Number of trees in dataset: **5,048**
Number of trees assessed: **4,150 (82.2%)**

Table 63: The proportion of Southern Grampian Shire's urban forest at risk in future temperatures

	Trees				Species			
CLIMATE SCENARIO	green	yellow	orange	red	green	yellow	orange	red
Current	66%	12%	6%	0%	85%	10%	3%	2%
Emissions limited (RCP4.5 2040)	38%	30%	13%	4%	64%	17%	15%	4%
Business as usual (RCP8.5 2070)	29%	33%	3%	14%	52%	21%	17%	10%

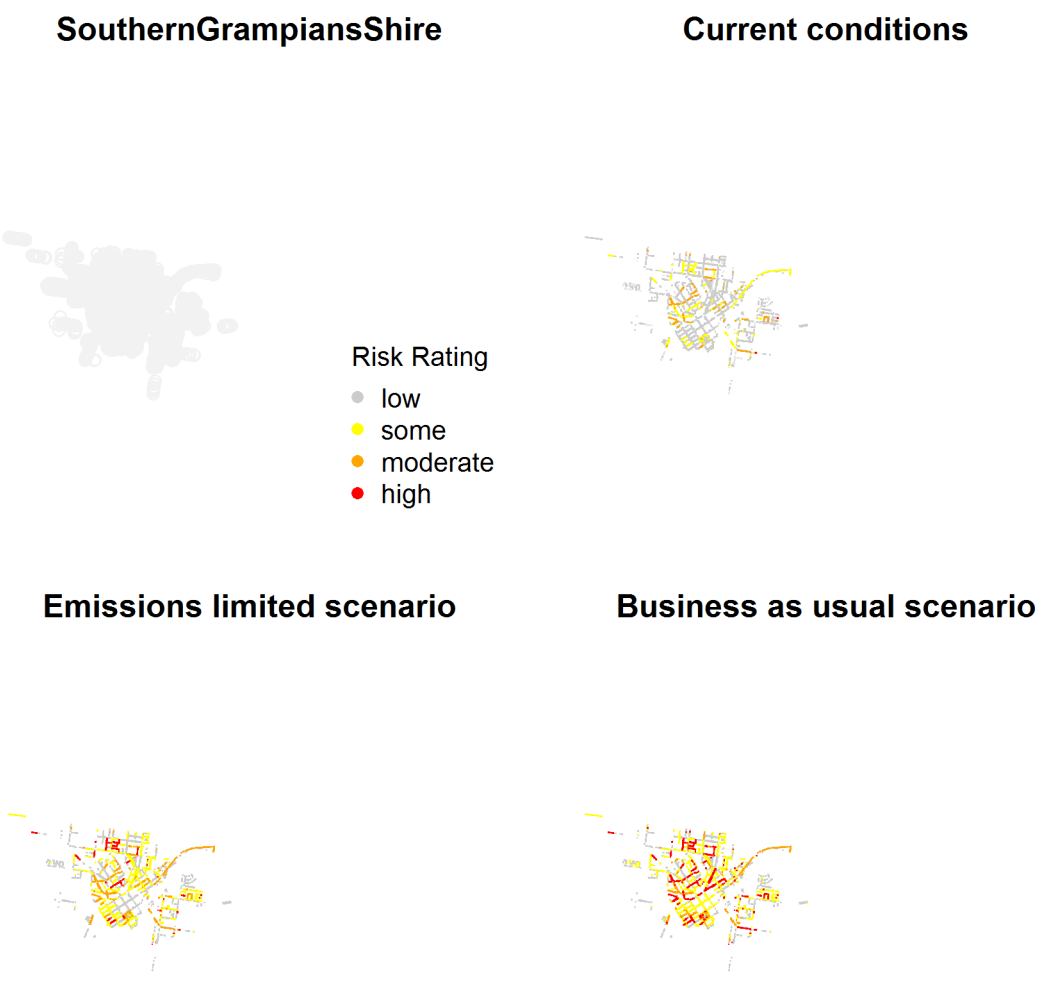

Figure 35: Risk to individual trees within Hamilton's urban forest colour coded for temperature risk under current climate conditions, an emissions limited climate scenario (RCP4.5 by 2040) and a business as usual scenario (RCP8.5 by 2070).

Table 64: Temperature risk of the most common species in Southern Grampians Shire.

No	Species	Abundance (%)	# trees	Current climate	RCP4.5 future	RCP8.5 future
1	*Prunus cerasifera*	15.8%	657	green	yellow	yellow
2	*Callistemon spp.*		399			
3	*Eucalyptus spp.*	9.5%	394	green	green	green
4	*Prunus spp.*	8.0%	331	green	yellow	yellow
5	*Fraxinus excelsior*	7.1%	296	orange	orange	red
6	*Quercus robur*	5.8%	242	yellow	orange	orange
7	*Platanus acerifolia*	5.1%	211	green	green	yellow
8	*Photinia spp.*		207			
9	*Crataegus monogyna*	4.9%	203	yellow	red	red
10	*Melaleuca spp.*	4.6%	192	green	green	green
11	*Lagunaria patersonia*	4.0%	165	green	green	green
12	*Ulmus minor*	3.9%	161	green	yellow	red
13	*Pittosporum eugenioides*	3.7%	153	green	green	yellow
14	*Malus domestica*	2.2%	92	green	yellow	orange
15	*Pinus spp.*	2.0%	84	green	yellow	yellow
16	*Acca sellowiana*	1.4%	60	green	green	green
17	*Unknown*		59			
18	*Leptospermum spp.*		58			
19	*Syzygium spp.*	1.2%	48	green	green	green
20	*Tristaniopsis laurina*	1.2%	48	green	green	green
21	*Hakea spp.*	1.0%	43	green	green	green
22	*Pittosporum undulatum*	1.0%	42	green	green	green
23	*Cupressus spp.*	1.0%	41	green	green	green
24	*Populus spp.*	1.0%	40	green	yellow	yellow
25	*Acacia spp.*	0.9%	36	green	green	yellow
26	*Cinnamomum camphora*	0.8%	35	green	green	green
27	*Pyrus spp.*	0.8%	35	green	green	yellow
28	*Grevillea spp.*	0.8%	33	green	green	green
29	*Melia azedarach*	0.8%	33	green	green	green
30	*Pyrus ussuriensis*	0.8%	32	green	green	yellow
31	*Brachychiton spp.*	0.7%	29	green	green	green
32	*Liquidambar styraciflua*	0.7%	28	green	green	green
33	*Nerium oleander*	0.6%	25	green	green	green
34	*Gleditsia triacanthos*	0.6%	23	green	green	green
35	*Malus spp.*	0.5%	22	green	yellow	orange
36	*Grevillea robusta*	0.5%	19	green	green	green
37	*Banksia spp.*		18			
38	*Sorbus aucuparia*	0.4%	18	orange	orange	red
39	*Ulmus parvifolia*	0.4%	17	green	green	green
40	*Betula pendula*	0.4%	16	yellow	orange	orange
41	*Allocasuarina spp.*	0.4%	15	green	green	green
42	*Hakea salicifolia*	0.4%	15	green	green	green
43	*Robinia spp.*	0.4%	15	green	yellow	yellow
44	*Washingtonia robusta*	0.4%	15	green	green	green
45	*Corymbia citriodora*	0.3%	14	green	green	green
46	*Agonis flexuosa*	0.3%	13	green	green	green
47	*Corymbia ficifolia*	0.3%	13	green	green	green
48	*Quercus rubra*	0.3%	13	yellow	orange	orange
49	*Acacia melanoxylon*	0.2%	7	green	green	yellow
50	*Camellia spp.*		7			

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